J. Robertson

MINISTRY OF
AGRICULTURE, FISHERIES AND FOOD

FOOD STANDARDS COMMITTEE

REPORT ON

BREAD AND FLOUR

LONDON
ER MAJESTY'S STATIONERY OFFICE
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1960

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The present terms of reference of the Food Standards Committee are:

To advise the Secretary of State for Scotland, the Minister of Agriculture, Fisheries and Food, the Minister of Health, and as respects Northern Ireland the Secretary of State for the Home Department, on the composition, description, labelling and advertising of food with particular reference to the exercise of the powers conferred on Ministers by Sections 4, 5 and 7 of the Food and Drugs Act, 1955, and the corresponding provisions in enactments relating to Scotland and Northern Ireland.

The following served on the Food Standards Committee during the preparation of this report:

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FOOD STANDARDS COMMITTEE REPORT ON BREAD AND FLOUR

INTRODUCTION

1. Before the war, nearly all bread was made from white flour of about 72% extraction* produced by the modern process of roller milling. In the late thirties, however, fears were expressed that such flour was deficient in the vitamins of the B complex, notably vitamin B_1. In 1940, the Government announced its intention to promote the enrichment of flour with synthetic vitamins and by 1942 as much as 40% of all white flour produced was enriched with synthetic vitamin B_1. It was, however, necessary during the later stages of the war to economise in the use of wheat and the extraction rate for National flour was therefore raised and remained between 80% and 90%. This made the bread less attractive in colour but ensured that sufficient of the nutrients naturally present in the wheat were conserved in the flour. A higher extraction rate inevitably resulted in an increase in the phytic acid content of bread. Phytic acid renders some of the calcium unavailable to the body; it was therefore decided to guard against the possibility of calcium deficiency by adding calcium carbonate to National flour.

2. In 1945, the Government convened a representative Conference† to consider future policy on bread and flour. It recommended unanimously that, after decontrol of the milling industry, regulations should be made to provide that all flours should contain minimum quantities of three specified nutrients: vitamin B_1, nicotinic acid and iron. The official medical and scientific members of the Conference held strongly the view that the prescribed minimum quantities of these nutrients should be retained in the flour from the wheat grain in the process of milling. The term "token nutrients" was applied to these substances in recognition of the fact that they occurred in the grain in association with other accessory food factors which it might also be desirable to retain. The representatives of the milling industry opposed the idea that the minimum levels of the three nutrients should be achieved by a compulsory extraction rate of 80%; they preferred to be completely free to add nutrients in any manner they thought fit.

3. Decontrol of the milling industry became possible in 1953 and the Flour Order, 1953,‡ was made. This defined the National flour used in price-controlled bread as flour with an extraction of at least 80%, but it permitted the sale of flour of lower extraction provided that the three nutrients were added in sufficient quantity to ensure a minimum content per 100 grams of flour of 1·65 mg. of iron, 0·24 mg. of vitamin B_1 and 1·60 mg. of nicotinic acid. Calcium carbonate in the form of creta praeparata§ had to be added to all flour except "wholemeal", which was defined as flour containing the whole of the product derived from the milling of wheat (i.e. with an extraction rate of 100%).

4. In May, 1955, a Panel was set up under the Chairmanship of Professor Sir Henry Cohen, now Lord Cohen of Birkenhead, to determine the differences in composition and nutritive value between (*a*) National flour, (*b*) flour of a lower extraction rate to which the three nutrients had been restored and (*c*) flour

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* See Appendix I Glossary.
† Report of the Conference on the Post-War Loaf, H.M.S.O., 1945 Cmd. 6701.
‡ S.I. 1953 No. 1282.
§ See Appendix I Glossary.

of a lower extraction rate to which the three nutrients had not been restored. The Panel was also asked to advise whether any such differences were significant from the point of view of the health of the population. They came to the conclusion that the available evidence did not reveal any ascertainable difference between National flour and flour of lower extraction rate to which the three nutrients had been restored, which would significantly affect the health of the population in any foreseeable circumstances. They added, however, that the differences between lower extraction flour enriched with the nutrients and lower extraction flour not so enriched were significant.

5. The publication of the report of the Panel was followed in September, 1956, by the abolition of the bread subsidy and the making of new regulations—the Flour (Composition) Regulations, 1956.* These regulations laid down that all flour should contain the nutrients in the amounts specified in the Flour Order, 1953, and that creta praeparata should be added to all flour other than flour containing the whole of the products derived from the milling of wheat.

6. At the same time that he announced the Government's intention to make the new regulations, the Minister of Agriculture, Fisheries and Food asked the Food Standards Committee to consider whether, in addition to requirements as to the content of vitamin B_1, nicotinic acid and iron, more extensive regulations governing the composition of flour and bread were needed to protect the consumer. The Committee were informed when they received this remit that the Government had already decided, as a matter of policy, against the imposition of a statutory minimum extraction rate of 80%.

7. We have considered the problem of more extensive regulations in the light of the importance of bread in the diet. Even though the diet is much more varied today than it was before the war and the total consumption of bread has declined, it is still the most important of the staple foods. The results of the National Food Survey for 1958 on the average daily intake of food showed that approximately a quarter of the calories, protein, iron, vitamin B_1, nicotinic acid and calcium were provided from bread and flour.

8. Since bread rather than flour is the product more frequently bought by the consumer, the best course would appear to be to lay down a nutrient standard for bread. After careful consideration of the problems involved, however, and in view of the arguments set out in detail in paragraphs 54–58, we have come to the conclusion that this would not be feasible at present. It seems to us that the most practical method of dealing with the problem is to lay down compositional standards for flour and to support them with a list of permitted ingredients for bread.

FLOUR

The Need for General Compositional Standards

9. Flour production is not a simple matter of extraction rate, but involves the cleaning and grinding of wheat and the separation of various streams in the mill, the balancing and blending of those streams and sometimes the mixing of different grades of flour. There are not, therefore, in practice hard and fast divisions between the different kinds of flour marketed. Two categories are well known to the public: white flour and wholemeal. Between these two a wide variety of flours is produced which it is convenient to call "wheatmeal". These

* S.I. 1956 No. 1183 and S.I. 1956 No. 1354 (S.67).

flours are normally used for making brown bread. The term "wheatmeal" has been in use in the milling industry for many years and seems to us to be the most satisfactory to use for these types of flour.

10. It should normally be possible to distinguish without difficulty between white flour and wheatmeal. White flour will normally contain only 0·1% or less of fibre* calculated on the dry matter, while wheatmeal is unlikely to have a fibre content below 0·5% or 0·6%. But there is no such clear distinction between wheatmeal and wholemeal in terms of fibre content. A comprehensive analysis of a sample alleged to be wholemeal will indicate whether it has the composition of wholemeal or not, but it is not possible to deduce therefrom that it is in fact a product of grinding the whole wheat with no addition or abstraction. It is therefore probable that any special standards for wholemeal could not be adequately enforced analytically on the basis of present knowledge.

11. With the production of such a wide variety of flour, it might be argued that no real purpose would be served by general compositional standards for flour as distinct from requirements to ensure the presence of the three nutrients and creta praeparata. We think, however, that the consumer should be protected against the possibility of brown bread being made chiefly by the addition of colouring matter to white flour and the provision of a fibre content for wheatmeal is a means to this end. It also seems to us that a standard should be prescribed for wholemeal flour even if it is not fully enforceable. It would be a means of indicating what sort of flour could properly and reasonably be described as "wholemeal". Wholemeal bread should, of course, be made only from wholemeal.

12. It seems to us reasonable to define wholemeal as flour of 100% extraction, provided that it is clearly understood that this means 100% extraction of the cleaned wheat. The normal commercial methods of cleaning remove the dirt, foreign seeds and other impurities, but only a negligible proportion of the outer layers of the wheat. There would, therefore, be no great difficulty in complying with a standard of 100% extraction of the cleaned wheat for wholemeal.

13. Some countries have a minimum statutory value for protein and a maximum value for ash, fibre and moisture in white flour. We consider, however, that owing to the use in the United Kingdom of varied grists made by blending three, four or more kinds of wheat, which may be home-produced or imported from any one of a number of countries, it would be unrealistic to prescribe a minimum protein content for flour. The addition of creta praeparata to flour makes it impossible to determine accurately the amount of ash natural to the flour. As to moisture content, figures for flours milled in the United Kingdom range from 13·2% to 15·4%; the majority are of the order of 14·5%. Moisture content is virtually self-limiting since, if it is excessive, the flour ceases to be free-flowing and is difficult to handle. Moreover, spoilage due to mould growth may occur, particularly in warm weather. We do not, therefore, think that a statutory limit is necessary.

14. The Flour (Composition) Regulations, 1956, define flour as "the product derived from or separated during the milling or grinding of wheat (other than wheat germ or wheat offals separated for disposal as such) and includes meal and any flour derived wholly or partly from wheat that, before being ground or milled, has been malted or subjected to any process, but does not include semolina". We think that this definition is adequate but it is confusingly and ambiguously expressed. In our view, it should be amended to read: "Flour

* See Appendix I Glossary.

means the product derived from or separated during the milling or grinding of wheat, whether or not any of the wheat has been malted or subjected to any process, and includes meal but does not include separated wheat offals, separated wheat germ or semolina".

15. We consider that wheatmeal should be defined as flour containing not less than 0·6% fibre calculated on the dry matter, and that only flour coming within this description should be described as "wheatmeal". Wholemeal should be defined as flour which contains the whole of the products derived from the milling of cleaned wheat, and the use of the description restricted accordingly.

The Addition of Nutrients

A. Requirements

16. In collaboration with the Committee on Medical and Nutritional Aspects of Food Policy, we set up a Nutrition Panel to consider the question of nutrient requirements. Their report is contained in Appendix III to this report.

17. They recommended that no increase in the present levels of the three nutrients and calcium was required on the grounds that there was no nutritional justification for the addition of these nutrients in amounts exceeding the present statutory requirements. They further recommended that no addition of riboflavin or pyridoxine was required.

18. We accept the recommendations of the Joint Nutrition Panel. Since about 90% of all bread consumed is white, the Panel concerned itself mainly with white flour, but we consider that there is every justification for continuing the present requirement that all flours (with the minor exception of flour for experimental use etc., which is already allowed for) should be required to contain not less than the minimum quantities of the three nutrients at present prescribed. It may be necessary to modify enforcement procedure since there is evidence that even with the best manufacturing practice it can never be certain that a prescribed standard will be reached by each and every sample that may be examined. These difficulties are considered in paragraphs 27–44 of this report.

19. The minimum levels of nutrients laid down in the present regulations correspond approximately with those naturally present in a flour of 80% to 85% extraction. Thus wholemeal flour will contain sufficient of the necessary nutrients without the need for any addition. Most but not all wheatmeal flours at present marketed will also do so. We would have liked to recommend that wholemeal and wheatmeal should be required to contain sufficient of the nutrients without addition, but this does not appear practicable. Apart from the fact that such a recommendation would entail the banning of satisfactory wheatmeals at present produced, it would probably prove to be unenforceable. We think, however, that it would be right to expect that wholemeal should not contain any added nutrients. We further consider that the flour constituents of any mixtures (e.g. pre-mixes sold to bakers) should conform to the nutrient requirements.

20. We accept the view of the Joint Nutrition Panel that the addition of calcium to flour should be continued at present levels. They noted that even with the addition of creta to flour, the National Food Survey records showed that there was a deficit in calcium intake in the larger families compared with the allowance recommended by the British Medical Association's Committee on Nutrition. Without the addition, the intake would, according to the survey, fall to about 70% of the recommended allowance. Even though some doubt has been ex-

pressed at the soundness of the allowance made in arriving at this figure, it is one that we do not think can be ignored, particularly as rickets is a condition in which the calcium intake may play a part. The Joint Nutrition Panel point out that in accordance with the recommendations of the Advisory Sub-Committee on Welfare Foods (1957), the vitamin D content of a number of foods consumed by children has been reduced. Vitamin D is concerned with the utilisation of calcium and the reduction affects the child's supply and reserves of vitamin D, not only in the first two years of life, but also later when flour becomes an important item in the diet. The recommendations of the Sub-Committee on Welfare Foods were made with the present intakes of calcium in mind. It may be that when a sufficient time has passed to observe how the recommendations of the Sub-Committee work out in practice it will be opportune to reconsider whether it is necessary to add creta to flour, but for the present we think it would be unwise to recommend any change, particularly as we understand that the Committee on the Medical and Nutritional Aspects of Food Policy is engaged on a study of the whole subject of calcium requirements.

21. We do not think, however, that the exemption of wholemeal from the requirement to contain creta praeparata should be abandoned. It might be argued that since calcium is added to prevent a deficiency in the general diet and since wholemeal has the largest phytic acid content of any flour, it is particularly necessary to add calcium to wholemeal. We think, however, that, in view of the study of the whole subject that is being carried out, this would not be an appropriate time to change the regulations on wholemeal.

22. We were asked by the Maltsters' Association of Great Britain to consider whether an exemption from the need to add creta praeparata could not be given to wheat malt flour. Wheat malt flour* is used either as an "improver" for white or brown bread or in the production of malt bread. When used as an "improver", the quantity is unlikely to exceed 2 lb. per 280 lb. sack of white flour and 4 lb. per 280 lb. sack of wheatmeal and in malt bread it will probably not exceed 13% of the total dry ingredients. Under 3,000 tons of wheat malt flour is produced annually and, in view of the small quantities used, we do not think that there would be any serious objection to exempting it from the requirement to contain creta praeparata.

B. Technical Considerations

23. At present calcium must be added to the flour in the form of creta praeparata or prepared chalk. This is a native form of calcium carbonate purified by elutriation.* None of the various devices for feeding the chalk directly into the flour stream at the mill is able to ensure that a completely intimate and uniform mixture of flour and chalk is obtained. In extreme cases, one sample of flour taken at the bagging point may contain no chalk, while another taken some time later may have more chalk than the maximum permitted. The basic cause of this wide variation is the peculiar physical properties of the chalk.

24. The Nutrition Panel have taken the view that provided the amount of creta added to flour is satisfactory on the average, individual deviations are of no nutritional importance. However, from the point of view of enforcement, more uniform distribution is very important. At the moment there is insufficient evidence to show whether any of the alternative forms of calcium (dicalcium phosphate, tricalcium phosphate, calcium sulphate, or calcium lactate) would be

* See Appendix I Glossary.

nutritionally as satisfactory as creta, nor is it known whether the substitution of one or other of them would result in a more homogeneous mixture. Further investigation on this subject would be worthwhile, but we do not feel justified at present in making any recommendations about the replacement of creta praeparata by other forms of calcium.

25. On the assumption that creta praeparata will continue to be used for some time to come, we think that further investigations should be made into methods of improving its distribution in the flour. The present Flour (Composition) Regulations provide that flour should contain not less than 235 milligrams and not more than 390 milligrams of creta per 100 grams of flour. In view of our recommendations on sampling in paragraphs 34–44 of this report, we see no necessity to increase this range.

26. If it eventually becomes possible and desirable to permit more than one source of calcium, we recommend that the present limits for creta should be replaced by maximum and minimum figures for the calcium content of the flour. Adoption of this course would remove the present anomaly whereby flour intended for conversion into self raising flour must be admixed with creta, although at a subsequent stage a far greater addition of a calcium salt, acid calcium phosphate, will probably be made. Indeed, we recommend that, even if creta continues to be the only permitted form of calcium addition, it should no longer be compulsory to add it to flour used for self raising flour by the addition of acid calcium phosphate at the rate of not less than $4\frac{1}{2}$ lb. per 280 lb. sack of flour.

27. Similar difficulties arise, although to a somewhat lesser degree, in adding the three nutrients to flour. This is done by the addition of a small quantity of master mix* (1 oz. per sack or $1\frac{1}{10}$ oz. in the case of patent flour). The analytical results obtained at the Government Laboratory during the Millers' Voluntary Flour Sampling Scheme in 1957 and 1958 revealed a large proportion of samples falling below the minimum laid down in the Flour (Composition) Regulations though others considerably exceeded it. The statutory requirement for vitamin B_1 is 0·24 mg. per 100 grams, but several samples contained less than 0·12 mg. while others contained more than 0·41 mg. Nicotinic acid has a statutory minimum of 1·60 mg., but the samples ranged from below 1·20 mg. to more than 3·19 mg. Taking the average of the four quarters of 1957, a third of all the samples contained less than the required amount of vitamin B_1 and a quarter less than the required amount of nicotinic acid. The variations seem to have been a little less in 1958 than in 1957.

28. The data for imported flours reveal a similar though not identical situation. The proportion of samples of Canadian flour coming below the statutory limit for vitamin B_1 is somewhat higher than in the case of home-produced flour, but for nicotinic acid the proportion is substantially lower (only 6%). Only a small number of samples of Australian flour have been examined, but they show a very much lower proportion of sub-standard samples for vitamin B_1 and a much higher for nicotinic acid. These differences may be explained in part by the intrinsic difference of Canadian and Australian wheats and by differing milling techniques.

29. None the less, it seems certain that the average nutrient content of flour is above the statutory requirement. The results obtained for 1957 indicate mean

* See Appendix I Glossary.

figures for the content of flour of vitamin B_1, nicotinic acid and iron as follows:

	Mean Content (milligrams per 100 grams)	*Excess over statutory minimum requirement (per cent)*
Vitamin B_1 ..	0·27	12·5
Nicotinic acid ..	2·2	37·5
Iron	2·1	27·5

30. Since the Joint Nutrition Panel have come to the conclusion that there is no case for raising the present statutory minima on nutritional grounds, it is reasonable to suppose that consumers are obtaining sufficient amounts of nutrients from flour.

31. Although there is apparently no nutritional problem, there is, as with creta, a serious problem of enforcement, and it is important to consider whether anything can be done to improve the distribution of the nutrients in the flour. This can best be considered by looking at the causes of the uneven distribution. The differences may partly be accounted for by variations in the natural content of the nutrients in different types of wheat and, to a very small extent, by variations in the composition of the master mix. There is no evidence that millers are not making every effort to add the master mix at the rate of 1 oz. per 280 lb. sack of flour. A greater measure of conformity to the existing statutory minima could clearly be obtained by increasing the rate of addition. Such an increase would, however, represent an increase in the cost of production for which there appears to be no justification on nutritional grounds.

32. It seems probable that with existing machinery there is no mechanical difficulty in adding master mix at the rate of 1 oz. per sack, but, though the machines may be reasonably satisfactory, in practice it appears to be impossible to maintain a uniform spread of such a small amount as 1 oz. per 280 lb. While occasional accidental interruptions in the supply of master mix may occur, the real difficulty is to mix the addition uniformly throughout the flour stream which travels at a high, though not a uniform, velocity. The time available for mixing depends on this velocity and on the extent of travel after addition, which in turn is limited by plant construction. Even if the master mix were added with mechanical precision, it would apparently still be difficult to ensure, except under the most favourable conditions, an intimate and homogeneous mixing of the addition with the flour stream.

33. It therefore seems undoubted that the most important cause of the variations in the nutrient content of flours containing added nutrients is the imperfect method of distributing the master mix. We think that further study and experiment is necessary to try to improve the method of addition, but we are satisfied that there is no nutritional justification for requiring a higher rate of addition of the master mix.

C. Regulations and Enforcement

34. Our conclusion is, therefore, that it is impossible at present—and unlikely to be possible in the near future—for millers to comply with the current regulations consistently. However careful they are, some samples taken from a comparatively large number of sacks of flour will be found to contain less than the required minimum of the nutrients or creta. In view, therefore, of these difficulties of the millers, local authorities are naturally very reluctant to institute proceedings. Since there are no advantages, and there may be dis-

advantages, in increasing the amount of the nutrients and creta added to flour, there seems no possibility of solving the problem within the normal methods of sampling laid down by the seventh schedule to the Food and Drugs Act, 1955, and by Section 30 of the Food and Drugs (Scotland) Act, 1956. We do not think that this means that statutory standards should be dispensed with. The fortification of white flour is a recommended policy based on nutritional considerations and it seems to us that there should be a sufficient control to ensure that the process is carried out in a satisfactory way. Statutory standards also provide an incentive to continue research into the problems of even distribution and maximum efficiency. The fact that it is not possible at present to recommend nutrient standards for bread makes the proper observance of nutrient standards for flour all the more important.

35. We set up an analytical panel to consider the reliability of the analytical methods available for control. Their report is printed at Appendix IV. They consider that, provided the sample of flour is truly representative and the method of analysis chosen is checked as they recommend, the enforcement of the present regulations or other similar legislation can be carried out equitably. We commend their conclusions on analytical methods to all those concerned with the enforcement of the regulations. We do not think, however, that it would be appropriate to insert actual analytical methods in regulations dealing with the composition of flour.

36. This brings us back to the problem of how to ensure that the flour sample is truly representative. Certainly with the small packs of flour such as are on sale in retail shops, some samples will be found to contain less than the required minimum of the nutrients or creta. Further, the types of flour on sale in retail shops are often different from those supplied to bakers. Some speciality flours which are made for bakers are not on sale in the retail shops at all. About 60% of the flour used in this country goes into bread manufacture and less than 10% is sold by retail. These considerations, together with the fact that any unevenness in the distribution of nutrients in the flour is bound to show up to a greater extent in the examination of relatively small quantities, leads us to the conclusion that sampling of the small packs of flour on retail sale is of very limited value.

37. Better supervision would be possible if most of the samples were taken at bakers' premises and possibly at other establishments, such as cake and biscuit manufacturers, where flour is used. The Food and Drugs Acts provide for sampling at such premises, but very little routine sampling of flour in this way has been carried out. There is at present no indication as to how samples at such premises ought to be taken. The problem is particularly difficult in view of the great difference in flour stocks at large and small bakeries. There is a further complication in that flour is now delivered to some of the larger bakeries in bulk wagons with pneumatic discharge to silos or hoppers. This system seems likely to be used to a greater extent with the increasing concentration of bread production at the large mechanised plants. It may be possible, after suitable investigation, to devise satisfactory methods for sampling flour at such bakeries, but it seems to us that it is hardly worthwhile to investigate and make provision for such methods if a more satisfactory system of control could be used. Furthermore, if any sample proved to be faulty it would also be desirable to trace it back to the mill concerned. This might not be possible in all cases—clearly not for imported flours—and, even where possible, the process might be difficult, not always certain, and in any case costly.

38. We think, therefore, that there are compelling reasons to depart from the normal sampling system laid down in the seventh schedule to the Food and Drugs Act, 1955, and the parallel Section of the Scottish Act, and to confine sampling of flour to mills and docks. Sampling at all mills and docks would cover the whole of the flour used in this country for there is no evidence of any change in composition during the interval between the despatch of the flour from the mill and its use by the final purchaser. Frequency of sampling at mills should be arranged according to production and varied according to test results. If present experiments are successful, it ought to be possible for some form of automatic sampling device to be installed at the mills and this in our view would represent an important advance. Small amounts of flour would be removed automatically from the stream at regular intervals and the mixture produced over any chosen period could be bulked and taken by the enforcement officer for analysis. Such a system would even out the irregularities in the composition of the flour stream and thus afford a truer picture of the general performance at the mill than any other method of sampling. In sampling imported flour at the docks—which amounts to about 10% of the flour used in this country—samples would have to be taken from a reasonable number of bags in each consignment and these samples would have to be thoroughly mixed to provide the final sample for analysis. It will be necessary to lay down rules as to the number of bags to be included in the taking of samples to represent consignments of different sizes.

39. It is not easy to give an estimate of the number of samples which would need to be taken for a satisfactory control. We are advised that under the voluntary scheme of sampling in mills, which was intended to provide data for the National Food Survey, every mill was sampled once a quarter for each kind of flour milled. This involved the taking of about 3,600 samples a year. The amount of sampling would clearly depend to some extent on whether or not automatic sampling devices could be arranged at the mills and might well be influenced by the considerations outlined in paragraph 41 below.

40. It is clearly also desirable that the analysis of samples should be confined to as few laboratories as possible. Consistency in methods of analysis is of importance if results over the whole field are to be comparable. In addition, the analysis for special constituents of occasional samples is bound to be expensive. In arranging for the analysis of a large number of samples the work can be better organised and with greater efficiency along routine lines and the cost would be less.

41. A further safeguard might be possible if the regulations allowed for compulsory official inspection of the millers' books to provide evidence that sufficient quantities of nutrients and creta, in relation to the amount of flour being produced, were being purchased by the miller. Section 123(1) of the Food and Drugs Act, 1955, and Section 56(8) of the Food and Drugs (Scotland) Act, 1956, make provision for regulations of this kind. Such an inspection, combined with periodic analysis of the composition of the master mix and a check of the arrangements for adding it and for adding creta, could be used in combination with the sampling operations.

42. If such a system as we have outlined above were adopted, we think that food and drugs authorities generally should probably not continue to take proceedings for non-compliance with the requirements for nutrients and creta in flour on the evidence of samples taken in the bakeries and retail shops, though they would need to continue to take proceedings for other offences in relation

to such samples. If they were to continue sampling for the nutrients and creta, the miller whose flour on the average contained the required amounts might still find legal action being taken against a particular package of his flour that happened to be deficient. Such action would, in our opinion, nullify the advantages that we think would spring from our proposals.

43. If enforcement is confined to samples taken at the mills and docks, one method of dealing with enforcement would be to remove the responsibility from food and drugs authorities and to place it on some central inspectorate under the control of the Minister of Agriculture, Fisheries and Food in England and Wales and of the Secretary of State in Scotland. With such an inspectorate, the sampling could be organised in an efficient and economical way, irrespective of local authority boundaries. It would be a simple matter to organise centralised analytical laboratories for such an inspectorate or alternatively the work might be entrusted to the Laboratory of the Government Chemist. It would appear to be possible to make the appropriate arrangements by regulations under the relevant Sections of the Food and Drugs Acts. Proceedings in England and Wales could either be taken by the Minister under Section 109(1) of the Act or by food and drugs authorities on a communication from the Minister under Section 96(2) of the Act. Since all proceedings in Scotland are at the instance of Procurators Fiscal, no difficulties would arise there.

44. On the other hand, the creation of a Government inspectorate in this field would depart from the general pattern of the Food and Drugs Acts which rely on enforcement by local authorities and a departure of this kind involving the transfer of a local authority function to a Government Department should clearly not be pursued if the present well-tried local authority system could, if necessary with certain adaptations, be employed. The chief difficulty in practice would be the extra cost that might be thrown on some food and drugs authorities with limited financial resources. This is inherent in the pattern established by the Acts and arises in other aspects of food law enforcement. Local authorities are used to tolerating variations of this kind and it becomes a real problem only where the authority is compelled to incur expense that causes a disproportionate increase in rate costs. How far this kind of difficulty would in practice hinder an effective scheme of enforcement based on sampling at mills and docks we have no means of telling. The representatives of one local authority association who gave evidence before us suggested that this difficulty might be obviated if food and drugs authorities were to co-operate by means of a common fund. There might well be difficulty in securing voluntary co-operation of this kind and it might be found to be ineffective unless the Ministers had powers to compel co-operation, which would raise further difficulties.

Bleachers and Improvers

45. We asked our Preservatives Sub-Committee to advise us on the use of substances and processes for bleaching or "improving" flour, having regard to the need for such treatments and the possible health hazards. Their report is printed at Appendix V.

46. They recommend that at the present time treatment with the following substances only should be permitted:—one bleaching agent: benzoyl peroxide; maturing agents: ascorbic acid, potassium bromate, ammonium or potassium persulphate, commercial chlorine dioxide; chlorine (for cake flour only) and sulphur dioxide (for biscuit flour only). They further recommend that the amount

of benzoyl peroxide allowed in flour should not exceed 50 p.p.m. They do not propose any specific limits for the maturing agents.

47. The Sub-Committee consider that no substance should be advertised for sale or sold as a bleaching and/or maturing agent for flour other than those recommended in the preceding paragraph.

48. We accept the views of the Preservatives Sub-Committee and recommend that their proposals should be accepted.

Other Additions to Flour

49. **Enzyme Active Ingredients.** We see no objection to the addition to flour of a small amount of malted wheat or barley, of a malt extract or of an amylase preparation. Where yeast is used, the presence of sugars is necessary for the effective working of the yeast and gassing of the dough. Wheat contains a variable amount of natural enzymes capable of splitting starch into sugars (i.e. amylases), but often this is insufficient to permit brisk fermentation and needs to be augmented. The amount to be added depends upon the original wheat and varies between about 4 oz. and 2 lb. per 280 lb. sack for malt flour and 0·5 and 2 oz. per sack for amylase preparations. With some flours which tend to give tough, inelastic doughs, the addition of small quantities of proteolytic enzymes may also be beneficial. We would therefore recommend that the addition of small amounts of enzyme preparations be permitted.

50. **Colour.** We understand that in the preparation of certain proprietary types of flour caramelised ingredients are used and there is also some production of caramel during the baking of bread. We see no reason to object to the presence of caramel in such flour, but apart from caramel we do not think that any added colouring matter should be allowed in any type of flour.

51. **Raising Agents.** The Food Standards (Self Raising Flour) Order, 1946,* requires that flour sold as "self raising flour" shall yield not less than 0·4% of available carbon dioxide. This is obtained by the addition of sodium bicarbonate and substances such as acid phosphate and acid pyrophosphate. Although white flour is generally used for conversion into self raising flour, we see no reason why any type of flour should not be used, provided that the description appropriate to the type is used and the available carbon dioxide conforms to the requirements of the Order.

52. **Others.** Emulsifying agents and similar substances have been increasingly used in bread manufacture in recent years. We do not think that they should be added to flour that is sold as flour, but we see no objection to the incorporation in "pre-mixes" of those that are allowed in bread. "Pre-mixes" are preparations which provide the baker with many of the ingredients required in bread making in a convenient form. We consider, however, that when emulsifying agents and similar substances are used in "pre-mixes" their presence should be disclosed.

BREAD

53. Bread may be defined as the product obtained by the doughing, fermenting and baking of flour with or without other ingredients. Yeast is the main raising agent used, but in a very few cases fermentation is replaced by, for example, a chemical liberation of carbon dioxide as in soda bread. The main ingredients introduced by the baker are water and salt, but small quantities of fat, sugar,

* S.R. & O. 1946 No. 157.

milk powder, malt, other cereals and soya flour and substances such as emulsifying agents, yeast foods and caramel are also variously added.

Nutrient Standard for Bread

54. Since bread is the article finally sold for consumption without further processing, and is eaten in far greater quantity than any other cereal product, forming a staple article of diet for all sections of society, it could be argued that the greatest measure of consumer protection would be obtained by a control of the composition of bread rather than of the flour from which it is made. However, though we consider a nutrient standard for bread desirable, we do not think it is a practical proposition, at any rate at present. Much more analytical research and much more experience will be necessary before such a standard can be introduced.

55. Our conclusion is based on the following considerations. The nutrients in flour are subject to variable losses during the bread-making process, depending mainly on the technique and plant employed and largely beyond the control of the baker. In particular, the loss of vitamin B_1, which is on the average about 15%, may vary between 10% and 22% in individual loaves.

56. The sampling of bread under the procedure laid down in the seventh schedule to the Food and Drugs Act, 1955, and in Section 30 of the Scottish Act, is bound to be difficult. The variable loss of vitamin B_1 in the baking process depends mainly on temperature; thus the vitamin content in the outer portion of the loaf of bread may be distinctly less than in the inner portion. This makes any fair and satisfactory division of the loaf for sampling purposes almost impossible.

57. There has so far been only limited experience in the analytical examination of bread for nutrients. The variety of ingredients used in bread making may have an effect on the extraction of the substances to be assayed and more work would be required, including evidence of the concordance obtainable between laboratories, before methods could be recommended for enforcement purposes. In particular, the creta added to flour may react with other ingredients and lose its identity so that the amount added cannot be determined in the finished bread. Some control could be exercised by a standard for total calcium in the bread, but the difficulties caused by uneven distribution would persist. Complications would also arise from additions made by the baker such as acid calcium phosphate and milk powder. These analytical difficulties might well result in the only enforceable standard being so low as to afford little protection to the consumer.

58. A standard for bread might also cause serious difficulties for the small baker who has to rely on the flour he has bought. The Food and Drugs Acts contain two clauses which are designed to protect the person who has unwittingly contravened the requirements of the Act, but neither of them would seem to be wholly effective in this case. Section 115 (Section 46 of the Scottish Act) provides a warranty defence, but although a baker may have bought flour under warranty, this warranty clearly could not cover the bread which had subsequently been made by him from the flour. Section 113 (Section 45 of the Scottish Act) affords a defence if a person wishes to allege that his contravention of the Act was due to the default of some other person. It might be extremely difficult for the baker to prove that the bread complained of had been made from flour which did not comply with the requirements of the Order. If he made bread from a number of different types of flour, he could not hope to be protected in any way by Section 113.

Ingredients of Bread

59. Since bread is the most important staple food, it is necessary to be particularly careful about its ingredients and we therefore consider that there is everything to be said for stating clearly what ingredients are permitted. A large number of ingredients are used in the making of bread today, although only on very rare occasions will they all be used at the same time. They perform various functions in the production of good bread under modern conditions. A permitted list is therefore bound to be of considerable length and complexity since it would obviously be wrong to prohibit the use of ingredients that are not harmful and perform a definite and useful function. We consider that the permitted ingredients should be laid down as follows.

60. **White Bread** should be made by baking a fermented dough made from white flour conforming to the standard for flour at present laid down in the Flour (Composition) Regulations, 1956, yeast and water and could contain the following additional ingredients:

(*a*) Salt, edible oïls and fats, milk or milk products, and sugars. These ingredients have been used in bread making from time immemorial and are commonly used by the housewife when she makes bread today.

(*b*) Enzyme Active Preparations: e.g. malt extract, malt flour, amylases and proteinases. The role of malt has been explained in paragraph 49. Amylases and proteinases are purified enzyme preparations which, when added to flour in small amounts, promote the same beneficial enzymic changes as the much larger additions of malt or malt extract.

(*c*) Soya bean flour, the total of such addition to be not more than two parts by weight to each hundred parts of flour. Soya bean flour stabilises dough consistency and is said to be useful in improving texture and producing a softer crumb.

(*d*) Prepared wheat gluten and wheat germ. Wheat gluten is the crude protein of wheat flour and wheat germ is the embryo of the wheat kernel, separated from flour at an early stage of milling.

(*e*) Poppy seeds, carraway seeds, cracked wheat or oat grain and oatmeal in or on the bread up to two parts by weight to a hundred parts of flour. These materials are often used as crust decorations and are sometimes incorporated in the dough itself.

(*f*) Yeast stimulating preparations containing harmless inorganic salts such as ammonium chloride and calcium sulphate. Yeast stimulants provide the necessary mineral requirements of the rapidly fermenting yeast.

(*g*) Emulsifying agents: super-glycerinated fats, stearyl tartrate and lecithin. These agents facilitate the smooth incorporation of fat into the dough and keep the crumb of the bread soft for a longer period. This recommendation is in line with that made in our Report on Emulsifying and Stabilising Agents.*

(*h*) Preservatives. Propionic acid, or calcium or sodium propionate or a mixture of any of these, not to exceed 0·3% by weight of the flour used. A preservative is useful in preventing rapid development of mould, especially in wrapped loaves. This recommendation is in line with that made in our Report on Preservatives.†

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* Food Standards Committee Report on Emulsifying and Stabilising Agents, H.M.S.O. 1956.
† Food Standards Committee Report on Preservatives in Food, H.M.S.O. 1959.

(*i*) Acetic acid, including vinegar, monocalcium phosphate and acid sodium pyrophosphate. The addition of these substances in hot weather helps to counteract the development of bacteria responsible for "ropiness" in bread.

61. **Brown Bread** should be bread having a fibre content of not less than 0·6% calculated on the dry matter and made chiefly from wheatmeal. It could contain any of the additional ingredients of white bread and also caramel. We prefer the term "brown bread" to "wheatmeal bread" which we think is likely to be confused with "wholemeal bread" by the public.

62. **Wholemeal Bread** should be bread made from wholemeal, without any addition of white flour or wheatmeal, and could contain any of the additional ingredients of white bread except milk and milk products, soya bean flour, prepared wheat gluten, wheat germ, oat grain and oatmeal.

63. **Soda Bread** should be bread leavened with sodium bicarbonate and a suitable acid constituent instead of yeast and could contain any of the additional ingredients of white bread except (*f*).

64. **Malt, Fruit, Nut and Egg Bread** should be bread containing malt, fruit, nut and egg respectively, in amounts sufficient to characterise the type of bread sold.

65. In addition to the caramel which may, as has been said in paragraph 50, be present in flour used for making proprietary brown bread, it is also the practice of some bakers to add small quantities of caramel to maintain a uniform colour for their brown bread or to give an appearance acceptable in the particular locality. We see no objection to this practice, provided there is no danger of deceiving the consumer or of concealing an inferior product, but we do not see any good reason to allow the addition of other colouring matter in bread.

Moisture Content

66. Some water must be mixed with the flour and other ingredients used in bread making to produce an easily workable dough. If too much water is added, the dough becomes sticky and does not cut cleanly; if too little, it becomes crumbly. There is therefore an optimum amount of water that can be added to any particular batch of flour and any appreciable increase will lead to difficulties in the later stages of bread making. Before baking, the baker must decide what amount of dough should be placed in the tin to give a loaf of the required statutory weight when subjected to his particular baking process. As it is baked, each piece of dough loses water in the form of steam. The amount lost depends upon the size and shape of the loaf, the time it spends in the oven and the oven temperature. Differences in moisture content between one loaf and another will also be caused by differences in water absorption between batch and batch of flour and the unavoidable variations of temperature within the oven. There are not likely to be large differences between loaves produced by a single baker working with modern plant, but there may be quite appreciable differences between the moisture content of loaves produced by different bakers. Further, a small loaf has generally a lower moisture content than a large one and a wrapped loaf a higher moisture content than an unwrapped one. The data we have seen suggest that it is possible for the actual moisture content of bread, discounting size and method of wrapping, to differ by as much as 10%, but the averages for groups of loaves at different periods of the year were remarkably constant. We do not think therefore that the consumer would be protected by the introduction of a maximum moisture content for bread. The limit would have

to be sufficiently high to accommodate all the variables met with in practice and would therefore be far above the general average. There would, of course, be little danger of a new process or substance being introduced into bread making which would have the effect of allowing bread to be sold with an increased moisture content if our recommendation for a permitted list of ingredients were accepted.

67. We think that there is some misconception in the public mind about the meaning of "steam baking". The idea that "steam baking" means baking by live steam is a completely mistaken one. "Steam baking" simply means that closed pipes in which heated steam circulates are present in the oven. The prime purpose of this system is to obtain the better equalisation of temperature throughout the entire oven in order to obtain more uniform baking. When live steam is injected into the actual oven atmosphere, it is mainly done in the initial stage of baking when sufficient steam has not been generated from the bread being baked to assist in the glazing. The amount of steam present in the interior of bakers' ovens differs little from the amounts present inside domestic ovens when bread is being baked.

Milk Bread

68. We were asked to report on milk bread in advance of our main report. This was done and a copy of our Report on Milk Bread is printed at Appendix VI. We recommended that milk bread should be required to contain not less than 4·2% by weight of whole milk solids or skim milk solids, calculated upon the weight of the loaf. We have since considered the representations made on our report and we have reached the conclusion that the calculation in paragraph 18 thereof is too restricted and that a figure of 3·6% should be substituted for 4·2% in the paragraph and in our recommendations.

69. We further recommended that labels and advertisements for milk bread should be required to bear a declaration in prescribed form "contains whole milk solids" or "contains milk solids not fat", as the case might be, and that, where milk bread was sold unwrapped, a notice should be conspicuously displayed at the shop to the same effect. Statements in labels or advertisements that milk bread was rich in any of the nutrients contained in milk, and words or pictorial devices suggesting that milk bread containing skim milk solids had been made with or contained constituents of whole milk should be prohibited.

Speciality Breads

A. Fruit and Malt Breads, etc.

70. These breads derive their distinct characteristics from the ingredients after which they are named, but, because of differences in local preference, the amount of the ingredient added varies widely in different parts of the country. This means that one designation is applied to a range of products that differ markedly in composition.

71. Malt bread is made by mixing into the dry ingredients ground malt or malt extract and the loaf which results is darker in colour but sweeter than ordinary bread and of a sticky texture. The amount of malt added varies from as little as 6% to as much as 13% of the dry ingredients. In fruit breads similar variations in the quantity of the particular fruit occur. Any standard would have to allow for these local variations and would therefore have to be below the lowest level of addition in current practice; it is very doubtful if it would serve a useful

purpose. We do not therefore recommend that a standard should be laid down governing the amount of the characteristic ingredient that should be present in these types of speciality breads.

B. Higher Protein Breads

72. A number of breads are made containing a higher proportion of protein than is normally found in ordinary bread. They are usually made by adding to the dough a suitable quantity of gluten, that is the crude wheat protein obtained by washing away the starch from flour. On the evidence that has been submitted to us, it seems that they may be divided into three categories: breads containing about 16% protein on a dry basis, breads containing about 21–22% protein, and products in which the protein proportion has been increased by the active reduction of starch. In paragraph 37 of their Report (Appendix III), the Joint Nutrition Panel have answered a number of questions on the nutritive value of these types of bread and the claims that should be permitted to be made for them. We are in agreement with the conclusions of the Joint Nutrition Panel.

73. We consider, however, that, even though 16% protein bread does not make an important additional contribution to the intake of protein, there is no doubt that the incorporation of 40 lb. of wet gluten or its equivalent, 14 lb. of dry gluten per sack of flour, produces a loaf which differs from ordinary bread, particularly in its physical characteristics. It has a more open texture, greater volume and is said to stale less readily. We consider that consumers should be able to distinguish and purchase this type of bread if they wish. The simplest course would seem to be to follow the pattern set by malt, currant and raisin bread, where the bread is called after the most characteristic ingredient. In this case, this type of bread made by the incorporation of the generally accepted quantity of gluten could be called "gluten bread". We recognise that this name is not an attractive one, and we are not suggesting that its use should be compulsory, but neither we ourselves nor the manufacturers and others who gave evidence before us have been able to think of a better name which is equally accurate. We understand that, by a new process, a flour fraction containing naturally a high percentage of wheat protein can now be manufactured. Such flours could produce a loaf containing between 16% and 22% without the addition of gluten. Such a loaf should also have the physical characteristics of a "gluten bread" and we consider that it should be subject to the same rules about claims.

74. We recommend that no special descriptions or special nutritional claims related to the protein content should be allowed for bread containing less than 16% protein. Breads containing more than 16% protein but less than 22% could be described as "gluten bread", but no reference should be made to protein as such. Bread containing more than 22% protein either naturally or by addition could be described as "high protein bread". No other description containing the word "protein" should be permitted except the description "contains X% protein".

75. We consider that the use of the term "starch reduced" should be applied only to bread or bread substitutes in which the carbohydrate content on a dry basis is less than 50%. We agree with the Joint Nutrition Panel that no food can properly be called "slimming". We also agree with their recommendation that no labels or advertisements should be allowed to suggest that particular types of bread have specific weight-reducing property. (The ban on slimming claims should, of course, extend to biscuits, rusks, rolls and certain cereal breakfast

foods.) Slimming claims for these types of bread are usually defended on the ground that the incorporation of a much larger amount of dry gluten results in a very considerable decrease in density and therefore each slice contributes fewer calories to the diet. It is contended that bread is normally eaten by volume and not by weight, but this is not necessarily true. No bread has any specific weight-reducing properties and slimming claims either made directly or by implication can only mislead the consumer.

C. Bread Containing Added Wheat Germ

76. Wheat germ breads are made with proprietary flours consisting essentially of a mixture of white flour and cooked wheat germ. The Joint Nutrition Panel in paragraph 37(6) of their Report (Appendix III) considered that there was no justification on nutritional grounds for making special provisions for bread containing at least 10% added processed wheat germ. They thought, none the less, that provision should be made in the regulations for a category of wheat germ breads. We agree that some provision for wheat germ bread is necessary and, in the absence of nutritional evidence, we agree that these standards should reflect good commercial practice. We therefore recommend that no bread should be described as "wheat germ bread" unless it contains 10% added processed wheat germ calculated on a dry basis on the bread. No claims to contain added wheat germ should be allowed on labels or advertisements for breads that do not conform to this standard.

Claims

77. Claims have been made in advertisements that certain breads are "enriched" with a particular ingredient, which in fact is present in amounts not significantly greater than in any ordinary bread. Other advertisements have made extravagant claims for the energy-giving properties of particular breads. We deplore all such exaggerated claims and we recommend that steps be taken to prohibit them under the powers granted to Ministers by Section 7 of each of the Food and Drugs Acts.

Summary of Conclusions and Recommendations

78. **Flour**

(*a*) Statutory limits should not be laid down for the protein, ash, fibre or moisture content of white flour (paragraph 13).
(*b*) The definition of flour in the present Flour (Composition) Regulations, 1956, needs amending to avoid ambiguity (paragraph 14).
(*c*) Only flour containing not less than 0·6% fibre calculated on the dry matter should be described as "wheatmeal" (paragraph 15).
(*d*) Only flour containing the whole of the product derived from the milling of cleaned wheat should be described as "wholemeal" (paragraph 15).
(*e*) No increase in the present level of the three "token" nutrients is required (paragraph 17).
(*f*) Wholemeal should not contain any added nutrients (paragraph 19).
(*g*) The addition of calcium to flour should continue at present levels (paragraph 20).
(*h*) The exemption of wholemeal from the requirement to contain creta praeparata should continue (paragraph 21).
(*i*) Wheat malt flour should be exempted from the requirement to contain creta praeparata (paragraph 22).

(*j*) Further investigation should be made into the possibility of using alternative forms of calcium and into methods of improving the distribution of creta praeparata (paragraphs 24 and 25).

(*k*) There is no need to increase the present range for the amounts of creta praeparata to be present in flour (paragraph 25).

(*l*) If more than one source of calcium is permitted, the present limits for creta should be replaced by maximum and minimum figures for the calcium content of flour. In any case, it should not be compulsory to add creta praeparata to flour used for self raising flour by the addition of acid calcium phosphate at the rate of not less than $4\frac{1}{2}$ lb. per 280 lb. sack of flour (paragraph 26).

(*m*) It is reasonable to suppose that consumers are obtaining sufficient amounts of the three nutrients from flour (paragraph 30).

(*n*) There is no nutritional justification for requiring a higher rate of addition of the three nutrients, but further study and experiments are necessary to try to improve the method of addition of the master mix (paragraph 33).

(*o*) It is impossible at present for millers to comply with the Flour (Composition) Regulations consistently, but this does not mean that statutory regulations should be dispensed with (paragraph 34).

(*p*) The methods of analysis set out in Appendix IV are commended to those concerned with the enforcement of the regulations. Analytical methods should not be laid down in regulations dealing with the composition of flour (paragraph 35).

(*q*) Sampling of flour for the purpose of compositional regulations should be confined to mills and docks. The use of some automatic sampling device in mills is desirable for efficient enforcement. Samples of flour at the docks should be taken from a reasonable number of bags and thoroughly mixed (paragraph 38).

(*r*) Provision should be made for compulsory official inspection of millers' books, periodic analyses of the composition of the master mix and a check of the arrangements for adding master mix and creta (paragraph 41).

(*s*) Enforcement could be carried out by a central inspectorate. If enforcement remains in the hands of food and drugs authorities, some co-ordination between them is desirable (paragraphs 43 and 44).

(*t*) Only certain bleachers and improvers should be permitted (paragraphs 45 to 48).

(*u*) The addition of small amounts of enzyme preparations should be permitted (paragraph 49).

(*v*) No added colouring matter apart from caramel should be allowed in any type of flour (paragraph 50).

(*w*) There is no reason why any type of flour should not be used for conversion into self raising flour, provided that the appropriate description of the flour is used and the final flour yields not less than 0·4% of available carbon dioxide (paragraph 51).

(*x*) Emulsifying agents permitted for use in bread should be allowed to be added to pre-mixes if their presence is disclosed, but they should not be added to flour sold as such (paragraph 52).

79. **Bread**

(*a*) A nutrient standard for bread is not practicable at present (paragraphs 54–58).

(*b*) A list of the ingredients to be permitted in various types of bread should be laid down (paragraphs 59–64).

(*c*) No colouring matter apart from caramel should be allowed in bread (paragraph 65).

(*d*) No maximum moisture content for bread should be laid down (paragraph 66).

(*e*) Milk bread should be required to contain not less than 3·6% by weight of whole milk solids or skimmed milk solids, calculated upon the weight of the loaf. Labels and advertisements for milk bread should be required to bear a declaration: "contains whole milk solids" or "contains milk solids not fat" as the case might be. Claims should also be controlled (paragraphs 68 and 69).

(*f*) No standards should be laid down governing the amount of the characteristic ingredient that should be present in fruit or malt bread (paragraph 71).

(*g*) No special descriptions or claims should be allowed for bread containing less than 16% protein. Breads containing more than 16% protein but less than 22% should be allowed to be described as "gluten bread", but no reference to protein as such should be allowed. Breads containing more than 22% protein should be allowed to be described as "high protein" bread, but no reference to protein as such, except in a statement "contains X% protein", should be allowed (paragraphs 72–74).

(*h*) The term "starch reduced" should only be applied to bread or bread substitutes in which the carbohydrate content on a dry basis is less than 50%. No label or advertisement should be allowed to suggest that particular types of bread have a specific weight-reducing property (paragraph 75).

(*i*) No bread should be described as "wheat germ bread" unless it contains 10% added processed wheat germ calculated on a dry basis on the bread. No claims to contain added wheat germ should be allowed for breads that do not conform to this standard (paragraph 76).

(*j*) Exaggerated claims for enrichment of bread or for energy-producing qualities should be prohibited (paragraph 77).

APPENDIX I

GLOSSARY

Extraction Rate refers to the extraction of the flour from the grain. It is the ratio of the weight of flour milled to the weight of grain used. It is usually expressed as a percentage; thus, if 80 lb. of flour is obtained from every 100 lb. of wheat milled, the extraction rate of the flour is 80%.

Creta Praeparata is the substance called "chalk" in the British Pharmacopoeia and is a fine white powder obtained from quarried chalk (native calcium carbonate) and purified by elutriation (q.v.).

Wheat Malt is wheat that has been steeped, allowed to germinate and then kilned to arrest germination.

Wheat Malt Flour is the product obtained by grinding wheat malt.

Fibre is the insoluble residue left after digesting a sample of flour successively with boiling acid and boiling alkali.

Elutriation. The process of suspending a pulverised mineral in water and allowing the suspension to settle by gravity in tanks. This brings about a separation of the finer particles which remain in suspension and are then drawn off from the coarser ones which settle more quickly and remain in the tank.

Master Mix. A powder containing the three pure nutrients: aneurine or thiamine (vitamin B_1), niacin (nicotinic acid) and iron, designed for incorporation into flour.

APPENDIX II

*List of interests which have given evidence or have been consulted**

Association of County Councils in Scotland
Association of Municipal Corporations
Association of Public Analysts
Counties of Cities Association
County Councils' Association
Metropolitan Boroughs' Standing Joint Committee
Society of Medical Officers of Health

British Baking Industries Research Association
Co-operative Bakery Trade Association
Federation of Wholesale and Multiple Bakers
Irish Association of Master Bakers
Maltsters' Association of Great Britain
National Association of British and Irish Millers
National Association of Master Bakers, Confectioners and Caterers
Self Raising Flour Association
Scottish Association of Master Bakers
Soil Association

Allinson Limited
British Arkady Company Limited
British Bakeries Limited
Energen Foods Company Limited
Hovis Limited
Novadel Limited
Nutrex Limited
Procea Products Limited
R. M. Scott (Ipswich) Limited
Henry Simon Limited
J. Walter Thompson Company Limited

Mrs. Margaret Brady
Mrs. Dorothy Cribben
Dr. D. W. Kent-Jones
John G. Osman, Esq.

* The interests which gave evidence on flour improvers are listed in Sub-appendix B of Appendix V, and on milk bread in Sub-appendix A of Appendix VI.

APPENDIX III

REPORT OF THE JOINT NUTRITION PANEL ON BREAD AND FLOUR

1. The Committee on Medical and Nutritional Aspects of Food Policy and the Food Standards Committee set up a Joint Panel consisting of three nominees from each Committee under the chairmanship of Professor Dunlop to study the nutritional problems involved in the Food Standards Committee's review of Bread and Flour.

2. The following were appointed members of the Panel:

Professor D. M. DUNLOP, M.D., F.R.C.P.
Professor R. C. GARRY, D.Sc., M.B., Ch.B., F.R.F.P.S.
Professor R. A. MORTON, Ph.D., D.Sc., F.R.I.C., F.R.S.
Professor B. S. PLATT, C.M.G., M.Sc., M.B., Ch.B., Ph.D.
Professor H. SCARBOROUGH, M.B., Ch.B., Ph.D., F.R.C.P.E.
Professor F. G. YOUNG, M.A., Ph.D., D.Sc., F.R.I.C., F.R.S.

3. The terms of reference of the Joint Panel were:

"to consider and make recommendations on the following matters:

(i) whether it is desirable on nutritional grounds to raise the current levels in flour for vitamin B_1, nicotinic acid and iron; and to make recommendations for bread;
(ii) whether it is desirable on nutritional grounds to continue the present compulsory addition of calcium and, if so, the required amount; and the most appropriate form or forms from the nutritional point of view;
(iii) whether a compulsory addition of riboflavin is required, and if so, the appropriate level;
(iv) to what extent claims for special dietary value or slimming properties in speciality types of bread are justified".

4. The Panel was also asked to consider the desirability of increasing the amount of pyridoxine in flour.

Background

5. The Panel was supplied with:

(*a*) extensive background information from the Secretariat of the Food Standards Committee;
(*b*) written evidence received by the Food Standards Committee following the invitation to submit evidence issued in the joint press notice of 7th August, 1956;
(*c*) the relevant statutory instruments and command papers.

The Panel also had access to published and some unpublished scientific work.

6. The Post-War Loaf Conference (1945) considered what flour was suitable to maintain good nutrition in the community and advised that regulations on the desirable composition of flour should provide for the following minima: vitamin B_1 0·24 mg/100g; nicotinic acid 1·60 mg/100g; iron 1·65 mg/100 g. They stated that these could be supplied by the flour of 80% extraction being milled at the time. In 1956, following representations from the milling industry, low extraction flours, with the nutrients added to bring their levels to these minima, were also permitted. The bread made from them was not subsidised. In 1956 the Panel on Composition and Nutritive Value of Flour reported that

in its view the available evidence revealed no ascertainable difference (in the context of its work) between the National Flour as defined in the Flour Order, 1953, and flours of lesser extraction rate to which thiamine, nicotinic acid and iron had been restored to levels similar to those in National Flour; and the subsidy on 80% and higher extraction breads was soon after removed.

7. Throughout the post-war period, therefore, although various extraction rates above 80% were enforced, flour policy was linked to an extraction rate of 80% or its equivalent as the minimum. During the period, rigid ration control and a system of fixed prices was gradually replaced by a free choice of a wide range of foods. The diet is therefore no longer the same as when the Post-War Loaf Conference made its recommendation.

8. Current statutory requirements are set out in the Schedule to the Flour (Composition) Regulations, 1956, as follows:

All flour other than flour containing the whole of the products derived from the milling of wheat

To contain creta praeparata as follows:

(i) Not less than 235 milligrams per 100 grams of flour, and
(ii) Not more than 390 milligrams per 100 grams of flour.

All flour

To contain quantities of the undermentioned nutrients as follows:

Iron	Not less than 1·65 milligrams
Vitamin B_1	Not less than 0·24 milligrams
Nicotinic acid or nicotinamide ..	Not less than 1·60 milligrams

per 100 grams of flour; such nutrients to be added (where addition is necessary), in the case of iron, in the form of reduced iron (ferrum redactum) or ferric ammonium citrate and, in the case of vitamin B_1, nicotinic acid and nicotinamide, in a form conforming to the standards of the British Pharmacopoeia or the British Pharmaceutical Codex.

Guiding Principles

9. We have assumed that:

(*a*) flour is a suitable vehicle for the addition of thiamine, nicotinic acid, riboflavin, iron and calcium to the diet;

(*b*) the amounts of these nutrients in flour should be such as to safeguard the health of all sections of the normal population, bearing in mind the contribution made by the rest of the diet.

10. In the evidence considered the intake of nutrients has been related to the allowances recommended by the British Medical Association's Committee on Nutrition (1950) which that Committee "believed to be sufficient to establish and maintain a good nutritional state in representative individuals of the groups concerned".

11. In considering both flour and bread we bore in mind available evidence on baking losses. We decided that the amount of nutrients in bread would depend on the amounts in flour and so did not call for separate recommendation from us.

12. Wholemeal flour was excluded from the present Regulation for reasons which had no nutritional basis. We have, therefore, not considered the desirability or otherwise of requiring the addition of creta praeparata to wholemeal flour.

Evidence

13. We obtained evidence on the amount of nutrients in the diet from the National Food Survey. This shows the consumption of food over the years and in which groups the estimated intake of nutrients compares least satisfactorily with the amounts recommended by the British Medical Association's Committee. Since neither this nor any food survey can show at what point a failure to provide the amounts recommended becomes of importance, we also took account of the evidence described below.

(1) **Thiamine, nicotinic acid, riboflavin.** In the absence of specific studies of representative population samples, we asked for information from certain clinicians known to be specially interested in the nutritional aspects of paediatrics, general medicine, and old age.

(2) **Iron.** We considered haemoglobin surveys carried out by the Ministry of Health and the Royal Infirmary, Cardiff, and records of the National Blood Transfusion Service.

(3) **Calcium.** Although the signs and symptoms of a specific dietary calcium deficiency in man are matters for discussion, nevertheless, inadequacy of dietary calcium may be a factor in diseases such as rickets and osteomalacia. We therefore took into account evidence reported by the Advisory Sub-Committee on Welfare Foods (1957) on the incidence of these conditions.

(4) **Pyridoxine.** We considered a report by Dr. Isabella Leitch and others on Pyridoxine: Metabolism and Requirements.

(5) We also studied statistics relating to stillbirths, neo-natal deaths and growth.

Findings

(*a*) Dietary

14. The essential information from the National Food Survey is set out in Sub-appendix A, Tables I, II and III.

These have been interpreted as indicating that:*

(1) the lower the income the lower the intake of nutrients;

(2) large families are liable to have intakes lower than those recommended by the British Medical Association's Committee;

(3) the position of families with adolescents and children is similar to that of those with four children or more;

(4) over the years 1952–57, the intake of these families for protein, calcium and thiamine has shown a slight diminution, but has not necessarily fallen below acceptable levels.

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* The calculations of the National Food Survey are based on the assumption that all groups waste 10% of all food. Such a figure may nevertheless not apply to all groups and it is probable that in large families and in the lower income groups less is wasted.

(*b*) **Clinical Evidence**

(1) *Thiamine, nicotinic acid and riboflavin*

15. The replies from the clinicians consulted were uniformly to the effect that deficiency disease ascribable to lack of these vitamins was not seen in the general population. Even among alcoholics, or in persons incapacitated or similarly predisposed, cases had rarely been seen. In our experience it is now most exceptional for patients with gross deficiency disease to be encountered in this country, and then only in cases of unusual poverty or neglect, among alcoholics or psychotics, or when precipitated by some associated condition such as the malabsorption syndrome, intestinal fistulae, and pyloric stenosis. It seems unlikely that the addition of riboflavin, or the further addition of thiamine or nicotinic acid to flour would have any effect in preventing such unusual manifestations.

(2) *Iron*

16. The female is for obvious reasons at greater risk of iron-deficiency anaemia than the male and, as shown in the Medical Research Council (1945) Survey of 1943, anaemia is most prevalent in women in the second half of the child-bearing span. The block diagrams in Sub-appendix B show the haemoglobin levels of two representative samples of housewives surveyed by the Ministry of Health in 1951 and 1952. (Comparable groups in the M.R.C. 1943 survey showed very similar levels.) 3·7 % and 5·0 % in the two Ministry of Health surveys had Hb. levels of 70% (10·4 g/100 ml.) or less.

17. No data are available for 1953, but in 1954 the Ministry of Health initiated a system of record of the percentage of female volunteers for blood donation rejected, on first attendance, for anaemia. These show that in the years 1954 to 1958 the percentages with haemoglobin levels of 85% (11·9 g/100 ml.) or less were 8·3, 9·1, 8·3, 7·5 and 6·5 respectively. Even allowing for the fact that blood donors are a selected community, there is evidence that an appreciable proportion of women in this country are anaemic. The Cardiff survey and our own clinical experiences support this.

18. As Sub-appendix B shows, the mothers of large families have lower than average haemoglobin levels. Similarly, the M.R.C. 1943 Survey reported that with increase of family size there was a lowering in the average haemoglobin level of mothers.

19. Whilst "iron-deficiency anaemia" responds to medicinal doses of iron, there is no certainty that an increase in iron intake of a few milligrams, such as would follow moderate fortification of flour, would reduce the incidence of such anaemia.

(3) *Calcium*

20. The Advisory Sub-Committee on Welfare Foods (1957) reported evidence of some though very little rickets, of which some was in children over the age of two, and no deficiencies of vitamin D in expectant and nursing mothers.

21. It is known that rarefaction of bone, fracture following only moderate injury, and spinal deformities, are not uncommon among the middle-aged and elderly, but to what degree, if any, a lack of dietary calcium is responsible is unknown. From 1952 to 1957, old age pensioner households obtained, according to the records of the National Food Survey, about 1 g. of calcium daily from their food. This represented about 112% of the amount recommended by the British Medical Association's Committee.

(*c*) Statistical Evidence

22. The most sensitive index of nutrient deficiency may be impairment of growth or reproductive performance. Sub-appendix C shows that in 1950, when the last analysis of this sort was made, the prevalence of stillbirths and neo-natal deaths tended to be higher in the lower social classes. It also indicates that children grow more slowly in large families and lower social classes.

23. Overall, the increase in the rate of growth of school children since before the last war has continued over the post-war period (see, for example, Boyne *et al* 1957). The average growth rates may conceal the fact that growth is slower in the large families.

24. No evidence is available to show whether or not the trends noted above have a nutritional cause, still less whether lack of any of the nutrients considered here is responsible.

Discussion

(*a*) General Considerations

25. The absence of frank dietary deficiency disease does not necessarily indicate that there is no need for additional safeguard, for the earliest signs of deficiencies may be non-specific in nature, and the evidence is not such that the existence of minor dietary deficiencies can be excluded. Although growth rates during the present century have in general accelerated, there is still a tendency for growth to be relatively slower in large families and lower social groups, which is consistent with the National Food Survey data. Stillbirth and neo-natal death rates are also relatively higher in the lower social groups.

26. "Desirable levels" for our purpose, are those which safeguard groups which need safeguarding. They are considered under the appropriate heads below. We realise that in safeguarding the needs of one section of the community with a low flour consumption, some other section with a high flour consumption may consume more of a nutrient than is necessary. In our opinion this is not likely to be harmful.

(*b*) Thiamine

27. The intake appears to exceed requirements and clinical deficiencies are virtually non-existent. Accordingly, we believe that the present statutory requirements are satisfactory.

(*c*) Nicotinic acid

28. Although much of the nicotinic acid in flour is bound and not readily available for metabolic processes, it is now known that nicotinic acid can be synthesised in the body from the amino-acid, tryptophan. Calculations based on National Survey figures show that the average dietary intake of tryptophan, and of nicotinic acid itself, is sufficient to provide for the nicotinic acid needed and, accordingly, we believe that the present statutory requirements are satisfactory.

(*d*) Riboflavin

29. Though the survey data indicate that the intake of riboflavin may be slightly below amounts recommended by the British Medical Association's

Committee, there is virtually no evidence of deficiency in the general population; we therefore do not think that special safeguards are needed.

(*e*) Iron

30. The evidence of the National Food Survey is to the effect that average iron intakes are satisfactory, though the haemoglobin surveys show that there is a significant proportion of women with anaemia. The requirements of some women are abnormally high because of pathological conditions (e.g. menorrhagia and poor absorption).

31. The question arises, however, whether there may be other individuals whose condition should not be regarded as pathological, but who would benefit from an increased supply of dietary iron. For example, the evidence shows that the mothers of large families, either as a result of pregnancy or in the subsequent rearing of their families, often fail to maintain haemoglobin levels which are considered normal. There is no certainty that these mothers, or any other persons with lower than average haemoglobin levels, would benefit from an increase of iron in flour, say, to 3·0 mg/100 g, which is about the level in wholemeal flour. We know of no studies bearing directly on the point, even from countries where enrichment of flour to this level is obligatory. It seems highly desirable that experiment should be undertaken to assess the degree of benefit, if any, which would follow such an increase in this country. In the meantime we cannot recommend an addition of iron to flour in amounts which would have a therapeutic effect in iron deficiency anaemia.

(*f*) Calcium

32. Even with the addition of creta praeparata in flour, the National Food Survey records show a deficit in calcium intake in the larger families compared with amounts recommended by the British Medical Association's Committee. Without the addition the intake would, according to the survey data, fall to about 70% of that recommended. Scepticism has sometimes been expressed about the soundness of the allowances; but, in the absence of firm evidence on the subject, we decided to adopt them in the knowledge that they incorporate a margin of safety.

33. As already noted, rickets is a condition in which the calcium intake may play a part. In accordance with the recommendations of the Advisory Sub-committee on Welfare Foods (1957), the vitamin D content has since been reduced in a number of foods consumed by children. This reduction affects the child's supply and reserves of vitamin D, not only in the first two years of life but also later, when flour is an important item in the diet. It is pertinent that these recommendations were made with present intakes of calcium in mind. In the Panel's view, these considerations are not necessarily an argument for permanent retention of added calcium in present amounts, but rather for its retention until a sufficient interval has elapsed to observe how the recommendations of the Advisory Sub-Committee on Welfare Foods work out in practice.

34. In the meantime, further evidence may accrue in relation to desirable calcium intake, and, perhaps, also on the hazards with which the Welfare Foods Sub-Committee was concerned. In view, therefore, of this and of the lack of knowledge as to what, if any, ill-effects would follow a reduction of the intake of calcium of older children and adults, we recommend that calcium should continue to be added to flour in the same amounts as at present.

35. As regards the form in which calcium should be added, we do not think it would be useful to try to compare the nutritional properties of the various calcium salts. In our opinion, if there are grounds for thinking that any particular calcium-containing preparation is superior to creta praeparata for technological reasons (for example, because it is easier to mix with flour) that preparation should then be examined from the nutritional point of view.

(*g*) Pyridoxine

36. The Committee on the Medical and Nutritional Aspects of Food Policy asked us to consider whether it would be desirable to raise the level of pyridoxine in flour. We decided that this matter could only be reviewed if we had estimates of human pyridoxine requirements and of the amount of pyridoxine supplied by the diet. In the present state of knowledge, both estimates are difficult to make and conclusions reached are tentative. We invited Dr. Isabella Leitch, Director of the Commonwealth Bureau of Animal Nutrition, to survey the relevant literature on pyridoxine requirements, and her conclusion was that the maximum requirement of pyridoxine would be 0·6 mg. per 1,000 Cal. for an adult and 0·8 mg. per 1,000 Cal. for a growing child, and that the minimum requirement would be 0·45 mg. per 1,000 Cal. for everyone. We estimate the pyridoxine content expressed per head per day of total food supplies moving into consumption which provide just over 3,000 Cal. per head per day to be 1·2–1·8 mg. (see Sub-appendix D), over half of which comes from animal products. Thus, it appears that the national supply of pyridoxine is approximately adequate. Further, on the available evidence there seems to be no reason to believe that pyridoxine deficiency exists in the general population, although it is uncertain whether additional supplies might not prevent abnormalities of metabolism which sometimes exist in pregnancy. Nevertheless, on the present evidence we do not consider that any addition of pyridoxine to flour is necessary.

(*h*) Speciality Breads

37. In considering to what extent claims for special dietary value or slimming properties in speciality types of bread are justified, we confined our considerations to six questions put to us by the Technical Group on Bread and Flour appointed by the Food Standards Committee and have reached the following conclusions:

(1) A change in protein content in bread from 12½% to 16% (i.e. an increase of 25–30%) does not, in the context of the present United Kingdom diet, represent a significant increase in protein intake. In our view, such bread does not merit the term "protein enriched" or "with added protein" or any equivalent term. We recommend that no special description of such bread or any special claim about it should be allowed.

(2) A change in protein content from 12½% to 21–22% does represent a significant increase in protein intake and special claims should be allowed. We recommend that the term "high protein bread" should be used rather than "protein enriched bread". We also advise that it would be more appropriate to make comparisons between bread on a weight than on a volume basis.

(3) Reductions in carbohydrate content, caused by the addition of protein, from about 83% to about 77–78%, or about 72–73% on an equal weight basis, or about 64% on an equal volume basis, are not of nutri-

tional significance and the term "starch reduced" should not be allowed for such breads.

(4) A product, regarded as a substitute for bread, in which the carbohydrate content has been reduced to less than 50% by weight may be described as "starch reduced".

(5) No food can properly be called a "slimming bread". We recommend that no advertisement should be allowed to suggest that particular types of bread have a specific weight-reducing property.

(6) On the question whether there is any justification, on nutritional grounds, for making special provision for breads containing at least 10% of added processed wheat germ, we advise that there is no positive evidence to justify such action. Nevertheless, as there are no grounds for restricting manufacture of breads of this kind, we think provision should be made in the regulations for a category of germ breads. We are unable, in the present state of knowledge, to suggest a minimum percentage addition of processed wheat germ that would be nutritionally significant.

Recommendations

38. 1. Thiamine
2. Nicotinic acid
3. Iron
4. Calcium

} No increase on present levels is required. There is no nutritional justification for the addition of these nutrients in amounts exceeding the present statutory requirements, and no special claim should be allowed in respect of any such addition.

5. Riboflavin
6. Pyridoxine

} No addition is needed.

7. Speciality Breads

(1) No special description or claim should be allowed for any breads with a protein content of less than 21%.

(2) Breads with a protein content of 21–22% should be allowed to be described as "high protein bread".

(3) The claim "starch reduced" should not be allowed to be used except where the carbohydrate content has been reduced to less than 50% by weight compared with normal bread.

(4) No advertisement should be allowed to suggest that particular types of bread have an intrinsic weight-reducing property.

(5) Provision should be made in the regulations for a category of germ breads, although we are unable to suggest, in the present state of knowledge, a minimum percentage addition of processed wheat germ that would be nutritionally significant.

References

Boyne, A. W., Aitken, F. C., Leitch, I.: *Nutrit. Abst. Reviews* (1957), **27**, pp. 1–18.

British Medical Association: *Report of the Committee on Nutrition* (1950).

Medical Research Council (1945): *Spec. Rep. Ser.* No. 252, p. 48.

Ministry of Agriculture, Fisheries and Food: *Domestic Food Consumption and Expenditure* (1957); *Annual Report of the National Food Survey Committee*, H.M.S.O. 1959.

Ministry of Health, Department of Health for Scotland: *Report of the Joint Sub-Committee on Welfare Foods*, H.M.S.O. 1957.

TABLE I

Households of Different Composition within Social Classes, 1957. Comparison of Energy Value and Nutrient Content of the Diet with allowances based on the recommendations of the British Medical Association's Committee

(per cent)

	Class*	Households with one male and one female adult and						
		No other (both under 55)	children only				adolescents only	adolescents and children
			1	2	3	4 or more		
Energy Value	A	115	100	106	108	100	108	99
	B	117	107	105	101	102	103	94
	C & D1	113	108	100	95	94	100	89
Total protein	A	127	110	102	100	93	105	92
	B	121	105	99	91	90	97	84
	C & D1	117	105	94	87	80	92	79
Calcium	A	141	116	104	105	97	120	101
	B	138	112	103	95	89	111	90
	C & D1	135	110	98	88	79	104	85
Iron	A	137	119	115	113	109	121	108
	B	137	122	116	108	111	117	106
	C & D1	138	122	113	105	103	112	101
Thiamine	A	153	138	132	138	121	134	126
	B	148	133	130	123	124	129	117
	C & D1	141	136	124	119	115	122	108
Riboflavin	A	137	129	124	128	123	120	111
	B	124	118	114	109	106	107	95
	C & D1	116	114	109	99	94	100	88
Nicotinic Acid	A	172	149	139	141	122	152	135
	B	159	143	136	125	125	140	123
	C & D1	154	145	129	120	117	131	116

* Class is defined according to the gross weekly income of the head of the household. In 1957 the following limits were used:

Class	*Gross weekly income of head of household*
A	£18 or more
B	£10 10s.—£18
C & D1	Under £10 10s.

Table II

Households of Different Composition, 1952–1957. *Comparison of Energy Value and Nutrient Content of the Diet with allowances based on the recommendations of the British Medical Association's Committee*

(*per cent.*)

Nutrient	Year	Households with one male and one female adult and		
		Children only		adolescents and children
		3	4 or more	
Energy Value	1952	99	101	93
	1953	99	100	95
	1954	101	99	98
	1955	102	98	97
	1956	101	100	96
	1957	99	98	93
Protein	1952	96	95	90
	1953	95	93	89
	1954	92	87	86
	1955	94	87	86
	1956	91	87	84
	1957	90	85	82
Calcium	1952	95	90	94
	1953	92	87	92
	1954	92	85	91
	1955	94	85	91
	1956	93	85	91
	1957	93	85	89
Iron	1952	102	101	99
	1953	103	100	100
	1954	101	97	99
	1955	104	97	100
	1956	101	98	98
	1957	105	103	101
Thiamine	1952	129	131	121
	1953	127	128	121
	1954	122	119	116
	1955	120	113	111
	1956	109	106	100
	1957	124	119	115
Riboflavin	1952	109	104	96
	1953	107	101	95
	1954	107	100	94
	1955	108	96	92
	1956	102	95	91
	1957	106	101	93
Nicotinic Acid	1952	123	121	119
	1953	124	122	121
	1954	120	115	118
	1955	123	113	115
	1956	114	111	108
	1957	124	119	120

TABLE III

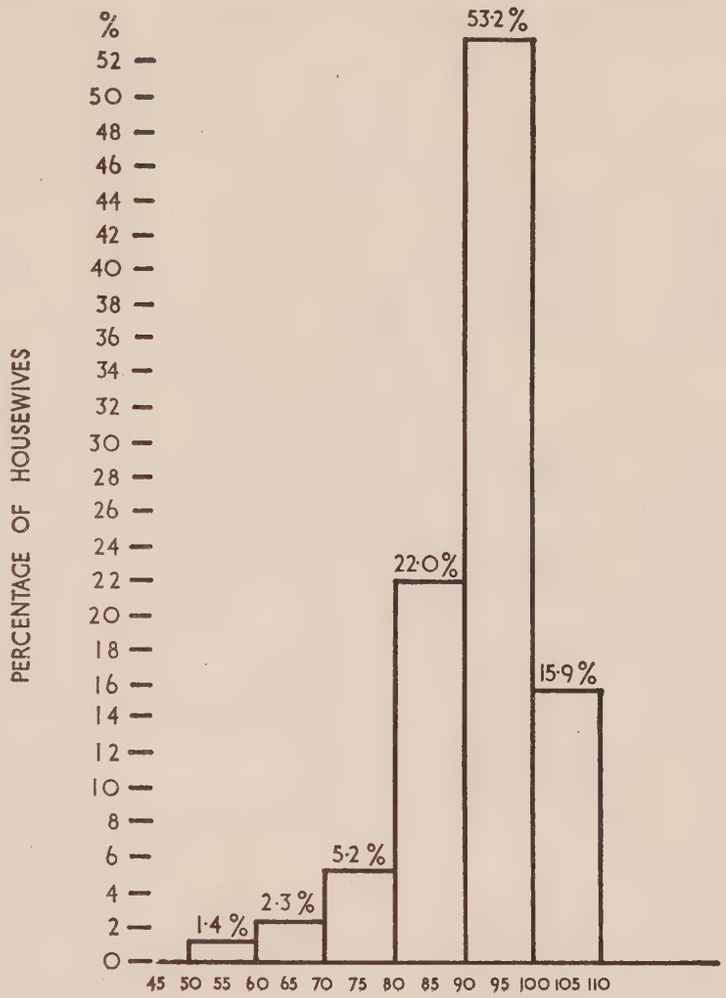
Comparison of the Nutritive Value and Adequacy of the Diets of Different Types of Households with and without Fortification of Flour with Calcium, Iron, Vitamin B_1 and Nicotinic Acid, 1957

(per head per day)

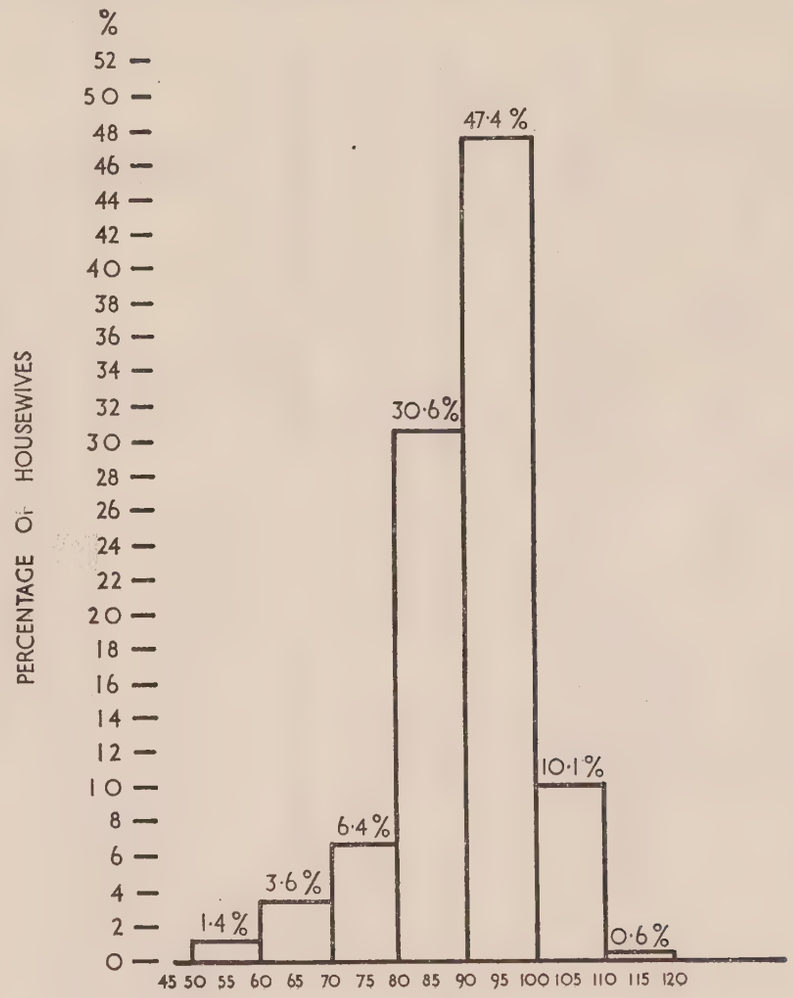
	All Households				Households with one male and one female adult and							
					4 or more children				Adolescents and Children			
	Total in diet		% of recommended allowances		Total in diet		% of recommended allowances		Total in diet		% of recommended allowances	
	including fortification	excluding fortification	including fortification	excluding fortification	including fortification	excluding fortification	including fortification	excluding fortification	including fortification	excluding fortification	including fortification	excluding fortification
	mg.	*mg.*	%	%	*mg.*	*mg.*	%	%	*mg.*	*mg.*	%	%
Calcium	1,028	782	106	81	888	668	85	64	962	709	89	66
Iron	14·1	12·7	113	102	11·1	9·9	103	91	13·3	11·8	101	90
Thiamine	1·29	1·02	129	102	1·02	0·77	119	90	1·22	0·93	115	87
Nicotinic Acid ..	13·8	11·8	138	118	10·2	8·4	119	98	12·8	10·7	120	101

HAEMOGLOBIN LEVELS

Haemoglobin levels of a random sample of 214 housewives from Tottenham and Walthamstow, 1951.



Haemoglobin levels of 359 housewives, on the records of the S.W. Metropolitan X-ray Service as having had a normal X-ray of chest on year before, 1952.



HAEMOGLOBIN LEVEL % HALDANE

Haemoglobin Levels of Housewives According to Parity, Tottenham and Walthamstow, 1951

No. of Pregnancies	No. in Sample	Mean Hb.% Haldane
0	14	90 2
1	62	91·4
2	64	90 8
3	31	91·7
4 and over	16	86·2

Inadequate information from 27 others.

Parity and Hb. Level in Sample of Housewives attending S.W. Metropolitan Mass X-ray Unit, 1953

Description	Number women	Mean Hb. level	Percentage of group below 70%
No children under 10—past menopause	76	91 8	2·6
Still menstruating—no children under 10	75	90·1	8·0
one child under 10	83	90·1	6·0
two children under 10	85	89·4	3·5
three or more children	22	84·4	18·2

Inadequate information on 17 others.

STATISTICAL EVIDENCE

Table I

Stillbirth and Neo-natal Rates in 1950
(*Registrar-General*)

Social Class	*Stillbirth Rate per* 1,000 *total births*	*Death Rate under* 4 *weeks per* 1,000 *live births*
I	16·7	12·9
II	19·6	16·4
III	22·1	17·9
IV	24·7	20·5
V	26·1	22·5

Registrar-General's Decennial Report, 1951, Part I, pp. 26 and 30.

Table II

Weights in kg. of 14*-year-old boys of different social class and family size, Bristol,* 1951 *and* 1955

1951	1 *child*	2–3 *children*	4 *or more*	
R.G. I and II* ..	50·3 (11)	52·4 (31)	53·6 (7)	52·1 (49)
R.G. III	52·4 (36)	51·9 (85)	45·5 (56)	50·0 (177)
R.G. IV and V ..	48·6 (14)	48·6 (40)	45·6 (72)	46·9 (126)
	51·1 (61)	51·2 (156)	46·0 (135)	49·2 (352)
1955				
R.G. I and II ..	57·3 (9)	50·6 (30)	53·0 (9)	52·3 (48)
R.G. III	53·4 (22)	49·1 (123)	45·8 (93)	48·2 (238)
R.G. IV and V ..	52·2 (7)	51·4 (44)	47·5 (61)	49·3 (112)
	54·1 (38)	49·8 (197)	46·8 (163)	49·0 (398)

Number of children in each group in brackets.

* Registrar-General's Social Classification.

Pyridoxine Content of the National Diet, 1956

Food	Pyridoxine			
	mg./head/day		% Total	% Total
	Min.	Max.	Min.	Max.
1. Dairy products and eggs, excluding butter	0·18	0·30	14·5	16·4
2. Meat and meat products (excluding pork, bacon and ham, including game and poultry)	0·33	0·47	27·0	25·6
3. Pork, bacon and ham	0·12	0·16	9·8	8·8
4. All fish	0·02	0·04	1·6	2·1
5. Potatoes	0·16	0·36	12·8	19·5
6. Vegetables, other than tomatoes	0·06	0·11	5·2	5·9
7. Fruit	0·04	0·07	3·2	3·7
8. Flour (white, brown, wholemeal and off-white)	0·24		19·2	12·8
9. Other cereals	0·02		1·3	1·2
10. Miscellaneous, pulses, nuts, cocoa powder, tea, coffee	0·06	0·07	5·2	3·7
11. Oils and fats (visible)	*	*	0·2	0·3
12. Sugar and syrups				
Total	1·23	1·84	100·0	100·0

* = less than 0·005.

APPENDIX IV

REPORT OF THE ANALYTICAL PANEL

1. The Analytical Panel was set up to study the analytical methods available for bread and flour and to consider analytical problems connected with the enforcement of regulations controlling either bread or flour.

2. The work of the Panel has included collaborative examination of samples of flour, specially prepared to ensure uniformity of composition, for the content of each of the three nutrients—vitamin B_1 (also known in this country as aneurine hydrochloride, but known internationally as thiamine hydrochloride), nicotinic acid and iron. No analytical work was carried out on the estimation of creta, or on the reliability of the methods available for the examination of bread.

3. Three collaborative exercises were carried out in all. The final exercise, involving the examination of a single sample of flour by thirteen different laboratories, was undertaken to resolve the effect of those factors leading to the somewhat disappointing degree of concordance in the results of the previous exercise, when three different samples of flour were examined by sixteen laboratories.

4. It was considered that the use of different methods, or variation in techniques of measurement, were likely to be important factors. In the final exercise, the use of a single specified method for each of the three nutrients was therefore stipulated. The experimental results thus obtained—with one exception, a high figure for iron content for which a rational explanation could not be found—were satisfactory. Statistical examination showed that the standard deviation calculated for each set of results was less than 10% of the mean value. It is therefore the view of the Panel that satisfactory methods are available for enforcement of the present Flour (Composition) Regulations, or similar regulations.

Conclusions

5. **Flour**

(*a*) There are generally accepted methods for the determination of vitamin B_1, nicotinic acid and iron. These have been published and need not be prescribed in detail.

(*b*) The determination of vitamin B_1 is satisfactory when using the method due to Ridyard (Analyst, 1949, **74**, pp. 18–24), and any alternative method adopted should be shown to give results strictly comparable with this method. It is recommended that analytical results should be expressed as 100% pure anhydrous vitamin B_1, not as hitherto as vitamin B_1 B.P.

(*c*) The determination of nicotinic acid is satisfactory if the recommended method of the Society for Analytical Chemistry, using Lactobacillus arabinosus (Analyst, 1946, **71**, p. 401), is used. Any chemical method or alternative microbiological method selected should be shown to give results strictly comparable with this method.

(*d*) The determination of iron by the method due to Pringle (Analyst, 1946, **71**, p. 491), using o-phenanthroline, is satisfactory, and any alternative method selected should be shown to give results strictly comparable with those obtained by this method.

(*e*) Due allowance when preparing standard vitamin B_1 solutions should be made for the possible variation in "true" vitamin B_1 content of Aneurine B.P., which, according to the terms of the monograph may vary within prescribed limits, as may also the moisture content. This implies that each batch of Aneurine Hydrochloride B.P. must be assayed for water and true vitamin B_1 content and the compensated appropriate weight of B.P. material used for the standard solution.

(*f*) A standard for creta in flour requires a wider tolerance than that contained in the present Regulations because the physical character of creta prevents its homogeneous incorporation in flour under present mill operations.

(*g*) Provided the sample of flour is truly representative, and the choice of method suitably regulated, the enforcement of the present Flour Regulations or other similar legislation can be carried out equitably.

6. **Bread**

(*a*) The methods for nutrients other than creta, used for flour are regarded as suitable for application to bread, except that, for the determination of vitamin B_1, it is necessary during the preparation of an extract to treat bread with a phosphatase (Analyst, 1951, **76**, p. 130) in order to free combined thiamine; subsequently the method of determination as for flour can be followed.

(*b*) There is relatively limited experience with these methods as applied to bread, and evidence on concordance between different laboratories is meagre. More work would be required before these methods could be recommended for enforcement purposes, and the Panel considers that the time and expense of such work would not be justified unless it was decided that standards for token nutrients should be applied to bread.

(*c*) In the baking of bread, any creta reacts with other ingredients and loses its identity. The amount added cannot therefore be determined on the finished bread. Some control could be exercised by a standard for total calcium in the bread, but the difficulties of uneven distribution referred to under "Flour" would still persist. Complications would arise, however, from additions made at the choice of the baker, such as acid calcium phosphate, frequently a seasonal addition, and milk powder.

(*d*) Destruction of vitamin B_1 takes place during baking, the greatest loss occurring at the crust, the least at the centre of the loaf. Representative sampling for enforcement purposes therefore presents great difficulties, and special sampling instructions would be needed should a standard for bread be prescribed.

APPENDIX V

PRESERVATIVES SUB-COMMITTEE

REPORT ON FLOUR IMPROVERS

We were asked to advise the Food Standards Committee on the use of flour improvers, the terms of the remit being:

> "To consider the use of substances and processes for bleaching or 'improving' flour, having regard to the need for such treatments and the possible health hazards; and to make recommendations accordingly".

For this study the Sub-Committee consisted of the *members:*

Sir CHARLES DODDS, M.V.O., M.D., D.Sc., F.R.C.P., F.R.I.C., F.R.S. (*Chairman*).
C. A. ADAMS, Esq., C.B.E., B.Sc., F.R.I.C., Barrister-at-Law.
M. COMPTON, Esq.
A. GLOVER, Esq., O.B.E., M.Sc., F.R.I.C.
W. A. GODBY, Esq., M.B.E., F.R.I.C.
E. B. HUGHES, Esq., D.Sc., F.R.I.C.
J. M. JOHNSTON, Esq., C.B.E., M.D., F.R.C.P.(Ed.), F.R.C.S.(Ed.), F.R.S.E.
H. E. MAGEE, Esq., M.B., D.Sc., M.R.C.P.
J. R. NICHOLLS, Esq., C.B.E., D.Sc., F.R.I.C.
Professor B. S. PLATT, C.M.G., M.Sc., M.B., Ch.B., Ph.D.
H. G. SMITH, Esq., B.Sc., Ph.D., F.R.I.C.
R. F. TYAS, Esq.

the following members of the Pharmacology Panel:

Professor E. BOYLAND, D.Sc.
Professor G. A. H. BUTTLE, O.B.E., M.A., M.R.C.S., L.R.C.P.

and the following who served as expert *assessors:*

J. B. M. COPPOCK, Esq., O.B.E., B.Sc., Ph.D., F.R.I.C.
L. J. HARRIS, Esq., Sc.D., D.Sc., Ph.D., F.R.I.C.
T. MOORE, Esq., Sc.D., D.Sc., Ph.D.
T. MORAN, Esq., C.B.E., D.Sc., Ph.D.

Joint Secretaries:

J. H. V. DAVIES, Esq.
W. M. SHORTT, Esq., M.Sc., F.R.I.C.

INTRODUCTION

1. Having regard to our terms of reference, we have confined our attention to substances or processes, used by the miller or baker, for the purpose of bleaching flour or for "improving" its properties for bread, biscuit, or cake making. Other additives such as enzyme preparations, yeast foods, aerating agents, or so-called "bread improvers" (other than bromate) do not come within our remit, and are, we understand, being studied by the Technical Group on Bread and Flour appointed by the Food Standards Committee, or have been considered under the general heading of "Emulsifying and Stabilising Agents" on which a report has been published.*

2. In the main, this report deals with the bleaching and "improving" of flour for bread making and for general use in the home. We have dealt separately with the chemical treatment of cake and biscuit flours, since this treatment aims at bringing about quite different changes in properties.

3. We have used the term flour "improver" or "maturing agent" for substances or processes which are used to alter the physical characteristics of the dough when the flour is mixed with water, and the term "bleaching agent" for substances which merely whiten the flour. Some substances have only an "improving" action, others only a bleaching effect, while some act in a dual capacity, with one or other property predominating.

4. In our examination of flour bleaching and maturing agents we have taken account of published work, the position obtaining in this and other countries, and the submissions made to the Food Standards Committee. We invited the views of certain organisations on specific points and heard oral evidence from some of them. A list of the organisations who gave evidence is given in Sub-appendix B.

HISTORICAL BACKGROUND

5. We are not the first official Committee which has considered the chemical treatment of flour in this country. In 1924, a Departmental Committee was appointed by the then Minister of Health to consider:

> "whether and to what extent the practice of treating flour with chemical substances is objectionable on grounds of health and whether it is desirable in the interests of public health that the practice should be prohibited or restricted, and in the latter case what restrictions should be imposed".

6. The Report of the Departmental Committee which was published in 1927[1] contains an account of their investigations, makes several observations on the possible hazards to health of flour bleachers and "improvers", and indicates the difficulties of detecting other than gross impairment of nutritive value by animal feeding studies. The substances then in use for the bleaching and/or maturing of flour were:

> nitrogen peroxide, benzoyl peroxide, chlorine, nitrogen trichloride and ammonium or potassium persulphate.

7. One of the conclusions reached by the Departmental Committee was:

> ". . . while a staple and indispensable foodstuff such as flour, the purity and wholesomeness of which are of cardinal importance to the community, should be jealously guarded against unnecessary treatment with foreign

* Food Standards Committee Report on Emulsifying and Stabilising Agents, H.M.S.O. 1956.

substances, we are not prepared on the present knowledge available to recommend the complete elimination of the bleaching agents and improvers now in use. Our view is that in the first instance it should suffice to limit the use of these substances to those which appear least open to objection when judged along the lines we have indicated. We think that chlorine, nitrogen trichloride and benzoyl peroxide should not be among these".

8. No statutory effect was given to the recommendations of the Departmental Committee and flour continued to be treated with chlorine, nitrogen trichloride (agene) and benzoyl peroxide. In particular, nitrogen trichloride gained such popularity with millers as a bleaching and maturing agent that by 1948 about 90% of the flour produced in this country was "agenised".[2]

9. In 1946, Sir Edward Mellanby[3,4] observed that when dogs were fed a diet containing a large proportion of bread made from "agenised" flour they developed running fits, and this was subsequently confirmed by other workers in this country and in the U.S.A. During the next few years intensive investigations to identify the causative agent were carried out which culminated in the isolation of the toxic factor and its identification as methionine sulphoximine.[5] Further experiments showed that methionine sulphoximine was toxic to other animals; it was found to be more toxic to rabbits and ferrets than to dogs but less toxic to mice and rats and much less toxic to monkeys. The amount of the sulphoximine likely to be present in flour treated with "agene" at the normal commercial levels is about 2 p.p.m., so that the average amount consumed by a man in one year is only about 2·5 mg./kg. bodyweight.[6] It has been estimated that even assuming no excretion or destruction of the sulphoximine, it would take a man 160 years to build up the dose which is toxic to monkeys. This may explain the absence of evidence of harmful effects in human beings consuming a normal diet containing bread made from agenised flour.[2]

10. The treatment of flour with agene was abandoned in the U.S.A. in 1949 and in Canada the following year. It was replaced by chlorine dioxide which does not cause the formation in the treated flour of methionine sulphoximine. In this country the subject was examined by a Scientific Committee under the chairmanship of Sir Wilson Jameson on which were representatives of the Ministries of Food and Health, the Medical Research Council and the milling industry. The findings of the Jameson Committee were issued as a Press Notice in January, 1950 (Sub-appendix C). The Committee recommended that the treatment of flour with agene should be discontinued and replaced by chlorine dioxide. This was accepted by the Ministers concerned and by the milling industry.

11. In December, 1954, the Minister of Food stated in Parliament that the milling industry had recommended their members to discontinue the use of agene and to give an undertaking that equipment for treating flour in this way would be removed from their mills by the end of 1955. He referred to the investigations undertaken by the Medical Research Council and to the effects observed of the other improvers; these were not considered sufficient to require the discontinuance of these processes, but the treatments were to be kept under close scrutiny in collaboration with the milling and baking industries.[7]

PRESENT POSITION IN THIS AND OTHER COUNTRIES

12. There is no legislation in this country which specifically permits or prohibits the use of flour bleachers and/or "improvers" as such. Our information is that

the substances at present in commercial use for the treatment of flour for bread making are:

chlorine dioxide, potassium bromate, ammonium or potassium persulphate, benzoyl peroxide, and, to a very limited extent, oxides of nitrogen.

In addition, some cake flours are treated with chlorine, and flour for the manufacture of biscuits with sulphur dioxide or sulphites. At present, practically all flour used for bread making in the United Kingdom is treated with bleaching and "improving" agents. It is understood, however, that the Armed Forces purchase untreated flour for use on board ship and for overseas consumption where storage is an important factor.

13. The position obtaining in several overseas countries may be summarised as follows:

U.S.A.

The following substances are permitted, in amount not more than is sufficient for bleaching and/or maturing:—oxides of nitrogen, chlorine, chlorine dioxide, nitrosyl chloride, benzoyl peroxide. "Bromated flour" is permitted to contain 50 p.p.m. potassium bromate and "bromated whole wheat flour" 75 p.p.m. The treatment of flour with bleaching and/or maturing agents must be declared.

Canada

Permits oxides of nitrogen, chlorine, chlorine dioxide and nitrosyl chloride; also the following up to the limits indicated:—benzoyl peroxide (100 p.p.m.), potassium bromate (50 p.p.m.), ammonium or potassium persulphate (250 p.p.m.). Treatment with bleaching and/or maturing agents must be declared.

Australia

Several States permit treatment with oxides of nitrogen, chlorine, chlorine dioxide and also potassium bromate for which there is a limit of 30 p.p.m. Some States require a declaration of the treatment the flour has been subjected to. Queensland has a limit of 3·5 p.p.m. sodium nitrite for flour bleached by oxides of nitrogen, and does not permit "chlorine bleached flour" to be used for bread making.

New Zealand

All bleaching substances are prohibited and only S.R. flour is permitted to contain potassium bromate up to 30 p.p.m.

South Africa

Permits only treatment with oxides of nitrogen.

Denmark

The only "improvers" officially banned are persulphates, but in practice the only substances used are chlorine dioxide, benzoyl peroxide and potassium bromate.

Sweden

Permits oxides of nitrogen, benzoyl peroxide (1,000 p.p.m.) and potassium bromate (100 p.p.m.).

Netherlands

Substances permitted are benzoyl peroxide (35 p.p.m.) and persulphates (125 p.p.m.), each of which may be admixed with specified amounts of calcium phosphate.

Norway

The only substance permitted is potassium bromate (100 p.p.m.).

Belgium, France, Western Germany, Italy

These countries in general do not permit the addition of any chemical substances for the bleaching or "improving" of flour. Ascorbic acid is allowed in France up to 300 p.p.m. It is also allowed in Germany, but if mention is made of added vitamin C, at least 100 p.p.m. must be added.

14. We thought differences in the legal position obtaining in the several countries were sufficiently striking to ask the British Embassies in the respective countries to endeavour to ascertain how the Continental countries managed without flour "improvers", and why Canada and the U.S.A., which produce "strong" wheats, permit such a variety of treatments.

15. The substance of the additional information we were able to obtain from the Embassies is as follows:

U.S.A.

Although U.S.A. wheats are generally "strong" it is necessary to allow the flour to mature, otherwise the dough is too sticky to be handled by the mechanical mixers and cutting machines. Natural maturing by storage for 3 to 6 months was practicable in the past, but as costs of warehousing rose it became necessary to shorten the time of maturing. Chemical "improvers" enable maturing to be accomplished in one day. It is on the beneficial action of these agents on the dough consistency, rather than the bleaching effect, that the addition of these substances hinges.

Canada

The majority of Canadians demand a bread of a very light texture, the 1 lb. Canadian loaf being about the same size as our $1\frac{3}{4}$ lb. loaf. Canadian bread is different from that of the U.K. in other respects, and frequently contains skim milk powder; plain bread is uncommon in the large centres of population. The machinery used by the multiple and wholesale bakers is geared to deal with the existing type of flour.

Belgium

The prohibition in Belgium of "mineral substances" and flour "bleachers" probably arose out of public health considerations since they are referred to as "harmful". Substances such as vitamins, dextrin, fatty acid esters and malt (which do not come within our definition of flour improvers) are customarily used in the preparation of bread.

France

France grows its own supplies of bread-making wheat. The bleaching of flour was opposed by hygienists before 1912. Since then two criteria have governed the decisions of French Ministers, namely, is the addition technically necessary and is it safe from the point of view of public health? The French Ministry of Agriculture do not consider that the bleaching of flour conforms with either

of these two conditions. Traditionally, French bread has the characteristic colour of wheat flour and the French public would treat as abnormal a more accentuated whiteness. Moreover, new techniques of bread making make it possible to obtain greater whiteness in the crumb without recourse to chemical substances.

Italy

Most of the Italian wheat requirements are met from domestic sources, but by trade agreements there is some importation from Argentine, U.S.A. and Turkey. The use of bleachers and "improvers" has never been officially allowed, presumably on health grounds. In Italy bread is usually made in the form of rolls rather than as loaves.

Germany

The German Research Council* could not recognise any necessity for the bleaching of flour.

CONSIDERATION OF THE NEED FOR THE CHEMICAL BLEACHING AND/OR "IMPROVING" OF FLOUR

(*a*) Bread flour

16. Freshly milled wheat flour has a yellowish tint due to the presence of natural pigments. The natural colour of flour is subject to variation depending upon the variety of wheat from which it has been obtained. When flour is stored for some time it becomes whiter and natural maturing takes place, which results in a more elastic and stable dough of enhanced bread-making properties. The changes which take place in flour on storage are undoubtedly due to oxidation by the oxygen in the air since no bleaching or maturing action results when flour is stored in a vacuum.[8] The natural maturing of flour does not occur at a uniform rate for all flours and depends on the variety of wheat from which it was milled and on the extraction rate, the "improvement" being most noticeable with high-extraction flours.[2] The optimum "improvement" is usually obtained when flour is stored for periods up to nine months; longer storage may be detrimental to the dough and bread-making properties. Experiments have shown that with some flours a noticeable "improvement" occurs after storage for a few weeks, while others showed no significant "improvement" in their bread-making properties on storage.[9]

17. About 50 years ago it was customary for the miller to mature flour by storage and not to sell freshly milled flour to the baker. Flour imported from America, which had naturally aged during transit, did not require further maturing and was extremely white.[10] There seems little doubt that it was to compete with imported flour that in 1901 the chemical bleaching of flour was first started in this country, to be followed a few years later by the use of "improvers".

18. It was found that by treating flour with certain oxidising agents both bleaching and "improving" could be effected very rapidly, thus lessening the costs and chances of spoilage by insect infestation associated with long storage.

19. Some of the substances employed exert only a bleaching action, others have only a maturing effect, while some act both as bleaching and "improving"

* A Committee of experts who advise the Federal Government in all cases where legislation has to be based on scientific facts.

agents. For each of the maturing agents there is a concentration which gives the maximum "improving" effect, and beyond which further treatment is detrimental; thus "improving" agents are self-limiting in use. The optimal levels of use depend on the type of wheat, the climatic conditions of growth and the extraction rate of the flour. Some flours respond better to one "improver" than to another, but when more than one is employed the amount of each is proportionately reduced. Thus by the judicious use of "improvers" the miller is able to smooth out the natural variations in different wheats and to produce flour of relatively uniform bread-making performance. Substances which exert only a bleaching effect, e.g. benzoyl peroxide, unlike maturing agents, are not self-limiting, but we understand that there is nothing to be gained by using excessive amounts.

20. The greater part of the bread produced in this country is machine made and the production of flour of uniform baking properties is of economic and technological importance to the baking industry. The bleaching of flour has no similar importance, though apparently there always has been and still is a demand for a very white flour in Scotland and the North of England.[1]

21. We have considered the methods of flour or dough treatment which do not involve the addition of a foreign substance, viz.: natural aging, heat treatment, and aeration.

(i) **Natural aging.** In addition to the difficulty and expense of storing the vast quantities of flour for several months, there is no reason to suppose it would be possible to produce commercially by natural aging, flour of a sufficiently uniform character to meet modern technological requirements. Further, the process is much slower if the flour is not bagged and storage in bags is now being superseded by bulk storage.

(ii) **Heat treatment.** The "improvement" of flour by heat treatment[8] is not practised in this country so far as we are aware. Heat treatment has no effect on the colour of the flour, and loaves made from it cannot compete as regards volume and texture with those made from naturally aged flour or chemically treated flour. The method would not appear to be a satisfactory practical substitute for chemical treatment at present.

(iii) **Aeration.** An aeration process involving very high speed mixing of the dough was tried a few years ago by one or two firms who reported that it gave bread which compared favourably, both as regards colour and texture, with that made from chemically treated flour. It is essential that the flour contain a sufficiency of oxidase enzyme and the addition of oxidase in the form of soya flour is usual with low extraction flours. Soya flour is not uncommonly added in small quantities in the process of bread making to improve the texture of the loaf. The aeration method has the drawback of requiring a large initial capital outlay on machinery, the installation of which may involve adaptation of buildings. We consider, however, that aeration is worthy of further investigation.

22. Many illustrations are to be found in the literature of the increase in loaf volume and uniformity in texture of the crumb of loaves made from chemically matured flour, but these give no indication of the effect on the colour. In order to form our own opinion sample loaves were specially made for us from untreated flour, and from the same flour after treatment with bleaching and/or maturing agents. As the grist available at the time was exceptionally good and required very little treatment, the differences in colour, loaf volume and texture

of bread made from the untreated flour and from the flour after the appropriate low level of treatment with chlorine dioxide were slight and could only be detected by a critical comparison. In order to demonstrate the effect of chlorine dioxide treatment on a weaker grist, such as bakers may have to use later in the season, a grist was used containing 15% of English wheat and the experiment repeated. In this case the effect of chlorine dioxide treatment was readily evident by the increased volume of the loaves made from it, but the difference in colour in the bread made from the treated and untreated flour was only apparent to the expert. Other loaves were made from unbleached flour of the current commercial grist with and without the small amount of bromate required to give the optimum improving effect. Loaves were also made from the same flour bleached with chlorine dioxide and benzoyl peroxide and "improved" with potassium bromate in amounts which would be sub-normal, normal, and excessive for the particular flour. The loaf volumes increased with increase of bromate up to the optimum level for the flour used, but when this was increased about 10 times, the loaf volume was distinctly less than that of those made from untreated flour; the bread was also of poor texture and appearance. The colour differences in the bread made from bleached and unbleached flour were no more noticeable than in the case of the chlorine dioxide experiments.

23. We have reviewed the information on the chemical bleaching and/or maturing of flour given in paragraphs 12–21. In our view the entirely different conditions under which the baking industry and the Armed Forces operate and the difference in the quantities of flour involved invalidates comparison. Nor do we consider the fact that some Continental countries manage without the chemical treatment of flour is particularly relevant in determining the need for such treatment in the U.K. Each country has its own particular type of bread to which it is accustomed and there is no reliable means of ascertaining whether bread of the Continental type would be generally acceptable in this country, and in our view a nation-wide survey would be unlikely to give a conclusive answer as to consumer preference. Of course, most European countries are not significant importers of flour. On general grounds we would prefer that the maturing of flour be accomplished without chemical treatment. The natural aging of flour cannot be relied upon to give a flour of sufficiently uniform performance irrespective of the grist available at any given time. Although aeration is not at present a practical commercial alternative to chemical treatment, it is sufficiently promising to justify further investigation by the industry. We have come to the conclusion that for the present day commercial production of bread to which the majority of the public have become accustomed, the use of some form of chemical "improver" is a technological necessity. But we think that further study should be given to alternative physical methods of bread making with the ultimate object of rendering chemical improvers unnecessary.

24. The need for substances which act only as bleaching agents is not so well founded, and no case can be established on technological grounds. Although the colour of the sample loaves made for us from unbleached flour was not appreciably different from those made from bleached flour, the current grist was of exceptional quality both as regards colour and strength, and different results might be expected with other grists. Flour bleaching has been practised in this country for about fifty years and enables the home-milled product to compete successfully with imported flour which undergoes natural bleaching in transit. We do not feel justified in advising the prohibition of flour bleaching agents, but consider that their use should be strictly controlled and, as they are not self-

limiting, that maximum levels of use should be prescribed for any which may be permitted.

(*b*) **Cake and Biscuit flours**

25. Cake flours are often treated with chlorine. The treatment is of particular importance with flour used in the preparation of Angel food and layer cakes. These cakes contain a much higher proportion of sugar or fat to flour than do ordinary cakes. For the satisfactory production of such cakes it is important that the flour particles be very evenly and finely divided, and that the normal gluten characteristics be partially destroyed by a heavy treatment with chlorine. The treatment with chlorine, which may be upwards of 4 oz. per sack of flour (> 900 p.p.m.), but which we understand very rarely exceeds 8 oz., causes not only the virtual destruction of the usual gluten characteristics but also desired changes in the hydrogen-ion concentration. It is also said to prevent the common fault of shrinkage which occurs with these cakes during cooling.[8] We understand that for production of these special cakes chlorine treatment could not be dispensed with at present.

26. Flour intended for biscuit manufacture is frequently treated with sulphur dioxide gas, or sodium bisulphite. The object of the treatment is to modify the "strength" of the flour rather than for any bleaching action the small amount of sulphur dioxide employed may have. The biscuit manufacturer requires a soft "weak" flour and if the correct type of wheats are not available the required degree of "weakening" can be achieved by treatment with sulphur dioxide.[8] We understand that the sulphite treatment of biscuit flour has been commercial practice for about 20 years. The usual level of treatment is about 20 p.p.m. sulphur dioxide. A few hours after treatment little or no sulphur dioxide can be detected in the flour, and none is ever present in the finished biscuits. It would seem that for the manufacture of biscuit flour light treatment with sulphur dioxide fulfils a technological need.

HEALTH CONSIDERATIONS

27. It is generally accepted that only treatments which do not significantly reduce the nutritional value of the flour or do not give rise to harmful substances by reaction with the constituents of the flour, should be allowed. The mechanism of the action of the several bleaching and "improving" agents is still largely unknown. The available evidence indicates that the changes brought about by chemical treatments are not usually identical with those which occur during natural aging, so it is necessary to examine the several chemical treatments of flour individually.

28. During the last decade or so attention has been drawn to the large number of chemicals used as "food additives" and to the desirability of their being adequately pre-tested to establish their safety for the proposed uses. At the same time there has been a steady growth in the literature on the biological testing of food additives and the assessment of the results. In the present state of knowledge expert opinions differ both as to what constitutes "adequate" biological examination, and on the evaluation of the results, so that a substance regarded as "safe for use" in one country may not be so regarded in another. These complex problems are at present being studied by the World Health Organisation and the Food and Agriculture Organisation of the United Nations, the ultimate aim being to obtain the widest possible measure of international uniformity in the testing and appraisal of the safety of food additives.[11]

29. In considering the biological data on flour bleachers and maturing agents, it should be noted that the gaseous substances do not appear in the treated flour as such, but are present in some other form; the solid substances may be present in the flour in the form in which they were added but not in the bread made from the treated flour. For these several reasons it is customary to carry out biological tests on either the treated flour, or bread made from it, using the normal level of treatment or a ten-fold concentration. The levels of treatment are usually based on those for the optimum treatment for flour of 80% extraction. The present-day bread flour is nearer 70% extraction for which the optimum commercial levels of treatment are about half that required for 80% extraction flour, so that the "ten-fold level of treatment" is about 20 times that used commercially in the U.K. at the present time.

30. It is not known precisely how "improvers" act on flour. This is not surprising in view of the diversity of chemical substances used and the possibility of chemical reactions, peculiar to each "improver", taking place. Modification of the protein moiety of the flour seems to be the net result, but the steps by which this is attained are to a large extent unknown. There is, however, no evidence that the formation of the agene toxic factor—methionine sulphoximine produced by nitrogen trichloride—can result from the interaction with flour of any of the improvers we are now considering.

RELEVANT DATA ON CHEMICAL SUBSTANCES IN USE IN THE UNITED KINGDOM FOR TREATING FLOUR

(*a*) Flour for Bread Making

31. **Chlorine dioxide.** This gas is used only by the miller and has both a maturing and a bleaching effect on the flour. As produced and used commercially, it contains about 20% of free chlorine and most of the chronic toxicity experiments recorded relate to the treatment of the flour with the commercial gas. The optimum level of use for flour of 80% extraction rate is given as 30 p.p.m., proportionately less being required for flours of lower extraction. Thus for the present-day bread-flours, of approximately 70% extraction, the amount required for the optimum "improving" effect is about 15 p.p.m. Some 80% of the flour produced in this country is now treated with chlorine dioxide.

32. Chlorine dioxide interacts readily with the lipids of flour. At commercial levels of treatment there is some oxidation of the unsaturated fatty acids but this occurs in no greater degree than in natural aging on storage for about a year. With "pure" chlorine dioxide there is no chlorination of the fat as occurs with chlorine. The examination of various protein fractions isolated from chlorine dioxide-treated flour indicates that the amino-acid residues attacked are methionine, cystine and tyrosine.[12] The reaction is predominantly one of oxidation with formation of cysteic acid and oxides of methionine. The quantity of modified amino-acids formed at a level of treatment of 30 p.p.m. is so small that the reduction in the content of the parent amino-acids is negligible. The most readily formed modification is methionine sulphoxide which in commercially treated flour is present in amounts similar to those found in untreated flour open to atmospheric oxidation. Chlorine dioxide inactivates vitamin E.[12] The total tocopherol content of flour may be reduced by over 80% following treatment with 30 p.p.m. chlorine dioxide or by about 50% if treated with the present commercial level of about 16 p.p.m.[13] The total tocopherol content, however, does not give a true picture of the loss in biological value as the ε form, which

predominates in flour, has practically no vitamin E activity and is the tocopherol most stable to chlorine dioxide. The loss of vitamin E activity which occurs at the 30 and 16 p.p.m. levels of treatment is not markedly different, being about 90% and 80% respectively.

33. Evidence that flour treated heavily with chlorine dioxide causes no obvious harm when consumed for relatively short periods has been obtained in experiments in the U.S.A. on man and several species of animals.[14] Thus dogs fed upon flour rations treated with up to 80 p.p.m. of chlorine dioxide remained in healthy condition for 13 weeks. Rabbits and monkeys grew well and remained healthy when given rations treated with chlorine dioxide for 6 weeks and 5½ months respectively. Over a period of 5 weeks rats grew equally well on diets containing flour treated with chlorine dioxide or untreated flour. No abnormalities were found in human subjects after receiving diets containing flour treated with chlorine dioxide at 80 p.p.m. and wheat gluten treated at 400 p.p.m. for 6 weeks.

34. In this country it has been reported that there was "no demonstrable difference" in the nutritional value of the proteins of chlorine dioxide × 10 treated flour* and those of untreated flour, as judged by the rate of growth of rats per unit of food eaten during their rapidly growing period, when they were fed on a diet containing 88·5% breadcrumbs made from either flour. Nor was there any difference between the growth of rats per unit of food on these two diets when they also contained added casein. A similar result was also obtained in experiments using flour enriched with lysine instead of breadcrumbs.[15, 16] Reports of this work however give no information about actual weight gains, as all such values have been "corrected" for the varying food consumptions of the different groups. The same authors also carried out toxicity tests in rats given diets containing 56·8% of flour over four generations, and concluded from their work as a whole that the chlorine dioxide treatment of flour does not significantly affect its nutritional value, nor is there any evidence of the formation of abnormal or toxic products.[17] Other workers however consider that the data presented do not permit of such clear-cut conclusions and point out, for example, that in the multi-generation tests growth rates were always slower when the diet contained chlorine dioxide × 10 treated flour than when treatment was at the normal level. Similar retardations in growth in rats fed upon breadcrumbs made from flour treated with chlorine dioxide either at 30 or 300 p.p.m., as compared with untreated flour, have also been observed in other multi-generation experiments.[32]

35. The possibility that decreased palatability, caused by the treatment of flour with chlorine dioxide, may be responsible for reduced growth rates in rats has been raised by some workers.[18, 19] Other workers, however, have found no evidence of this.[32] It has been recorded, for example, that the addition to diets of extra fat extracted from flour treated with chlorine dioxide at 300 p.p.m. makes them "unpalatable" to rats.[19] The effects of chlorine dioxide treatments, at the normal and 10-fold levels on the "palatability" of flour or breadcrumbs, without added fat, however, have not been studied. The relationships between palatability, nutritive value, food intake and growth require further investigation.

36. The destruction of vitamin E by chlorine dioxide has been confirmed in biological tests. Control rats given no source of vitamin E other than a high proportion of untreated flour or bread in their diet remain free from signs of

* That is of flour treated with 300 p.p.m. of chlorine dioxide; twenty times the present commercial level.

avitaminosis E. On the other hand, they develop typical lesions, including degeneration of the testes, if the flour has been treated with chlorine dioxide at the normal level.[18, 20, 21] The loss of vitamin E caused by chlorine dioxide is much greater than that occurring naturally during the storage of flour, which amounts to only 20–30% after 9 months.[22] Experiments by other workers[2, 23] suggest a loss of the same order. Adverse signs due to avitaminosis E caused by a diet containing flour treated with chlorine dioxide may be prevented by adequate dosing with vitamin E.[18, 20]

37. The only change in the nutritive value of flour which has been firmly established is therefore the loss of vitamin E. As already stated, however, the defect caused by chlorine dioxide may readily be made good, even in the rat, by supplying vitamin E from other sources. Flour and its products, even if untreated, could probably contribute only some 10% of the total vitamin E in typical human diets. There is therefore no evidence at present that the consumption of flour treated with chlorine dioxide, in mixed dietaries containing other sources of vitamin E, is harmful to man but we think that further studies are desirable.

38. **Nitrogen peroxide.** This gas was one of the first bleaching agents used in this country but no longer enjoys the popularity that it once had; we understand it is still used in at least one mill. There is no precise information as to the amount of nitrogen peroxide actually used, the millers being guided by the appearance of the issuing flour. In laboratory tests the maximum bleaching effect was obtained with 30 to 100 ml. of the gas per kilo of flour (approximately 60–200 p.p.m.)[24]; but it has been stated that 1 lb. of nitrogen peroxide is sufficient to bleach 250,000 lb. of flour (4 p.p.m.).[8] It has been suggested that the bleaching action of the flour pigments is due to nascent oxygen liberated by the interaction of nitrogen peroxide and water; the other reaction product, nitrous acid, remains in part as a residue in the treated flour. Commercially treated flour may contain residual amounts of sodium nitrite of between 3 and 4 p.p.m.

39. In highly bleached flour there is an increase in the soluble proteins and carbohydrates. About 6–7% of the nitrogen peroxide introduced is absorbed by the flour oil. The oil of heavily bleached flour on standing acquires the characteristics of an oxidised oil.[24]

40. The Departmental Committee which reported in 1927 did not consider the treatment of flour with oxides of nitrogen to be entirely free from objection, but regarded it less unfavourably than treatment with chlorine. The traces of nitrite which may be present in the treated flour were not regarded as deleterious.

41. We concur in the view that a residue of 3 p.p.m. or so of nitrite is not likely to present a health hazard, but consider that more information is desirable on the possibility of the production of other toxic substances. In the absence of long-term chronic toxicity studies there is insufficient evidence on which to assess the potential health hazard of this treatment.

42. **Benzoyl peroxide.** This crystalline solid was introduced as a flour bleaching agent about 1921,[25] and at the present time it is used to supplement the bleaching effect of chlorine dioxide in about 50% of the bread-flour produced in this country. It acts solely as a bleaching agent, and is customarily used in conjunction with maturing agents. Proprietary bleaching agents based on benzoyl peroxide are often diluted with a substance such as calcium acid phosphate.[1] The levels of use of benzoyl peroxide for an 80% extraction flour range from 15–45 p.p.m.[2], the average being about 30 p.p.m.

43. Benzoyl peroxide slowly oxidises the colouring matter of flour, three or four days being required for the maximum degree of whiteness to be attained, leaving a residue of benzoic acid in the flour. When used at the rate of 20 p.p.m., there appears to be little destruction of the essential fatty acids of the flour lipids, but 200 p.p.m. causes a significant reduction in the linolenic acid content.[26] Treatment with benzoyl peroxide may result in a reduction of the vitamin E content of the flour by about 30%.[27] No information is available of its action, if any, on other flour constituents.

44. The Departmental Committee of 1927 objected to the treatment of flour by benzoyl peroxide because it left a residue of benzoic acid which they regarded as undesirable in a staple food such as flour. So far as the residual benzoic acid is concerned, we have no reason to think that 50 p.p.m. in flour would be hazardous to health, but we consider that flour treated with benzoyl peroxide should be subjected to long-term chronic toxicity studies.

45. **Potassium bromate.** This crystalline substance has only a maturing action. It may be added by the miller, the baker, or both, and for convenience in use is customarily diluted with inert substances. The optimum level of use for a flour of 80% extraction is given as 20 p.p.m. and the normal usage as 10–15 p.p.m. The "improving" action of bromate does not take place until the flour is made into dough, and its use results in the final bread containing a residue of about 10 p.p.m. of potassium bromide.[28] We are informed that many bakers use bromate as a supplementary "improver". At high levels of use—about 200 p.p.m. —bromate has no significant effect on the vitamin B_1, riboflavin, or nicotinic acid content of flour or of bread made from it. No statistically significant differences in essential fatty acid content have been found in flour treated with 200 p.p.m. bromate, or in bread made from such flour.[29]

46. So far as the residue in bread of about 10 p.p.m. of potassium bromide is concerned we are satisfied that this would not be hazardous to health. Further longevity studies are indicated and more information is desirable on the products of interaction of bromate with the flour constituents.

47. **Persulphates of ammonia or potassium.** Both are crystalline solids which "improve" but do not bleach flour. Ammonium persulphate was one of the first chemical flour "improvers" to be used; the amounts quoted for the optional level of use range from 100 to 200 p.p.m.[8, 28], the normal level of use at present in the U.K. being about 110 p.p.m. Some proprietary products were at one time diluted with up to 75% ammonium sulphate to facilitate handling,[1] but the more general diluent nowadays is calcium sulphate. Within a short time of the dough being made persulphate cannot be detected, but only the break-down product, sulphate. Technologically persulphates are regarded as important by some millers. The amount of ammonium sulphate likely to be found in bread by the use of ammonium persulphate is about 90 p.p.m.[28]

48. At levels of up to 333 p.p.m. ammonium persulphate caused no significant alteration in the essential fatty acid content of the lipids of flour or of bread made from it.[26] Persulphate treatment has been reported to have no deleterious effect on the thiamine or riboflavin content of flour or bread made from it[30]; no information is available to us of the effects of persulphates on other constituents of flour.

49. Chronic toxicity studies have been carried out over several generations in rats.[31] The flour was treated with up to 1·0% ammonium persulphate (i.e. approximately 100 times the normal level of use). The diets, which contained either 78% flour or dried bread, were adequately supplemented with vitamins.

No adverse effects were observed in the rats on the bread diets, or in those on diets containing flour treated with up to 0·1% persulphate. Adverse effects were observed in the animals on the diet containing flour treated with 1·0% persulphate. The growth rate was retarded and reproduction and rearing of the young were impaired, but these adverse effects did not occur in the rats on the bread diet made from this flour, probably due to the breakdown of the persulphate in the presence of water to sulphate. Haematological and tissue examinations failed to reveal the cause of the ill-effects observed. Information is desirable on the nature of the substances formed in flour treated with persulphates.

50. **Ascorbic acid: Vitamin C.** This crystalline substance is one of the newer flour "improvers"; the optimum amount for 80% extraction flour ranges from 20–80 p.p.m.[2] Ascorbic acid is stated to be approximately as effective as bromate,[8] but it is more erratic in behaviour and, like bromate, its action does not take place until the dough stage. Ascorbic acid has no bleaching action and its vitamin activity is completely destroyed during the baking process.[12]

51. The treatment of flour with 200 p.p.m. of ascorbic acid does not result in any significant reduction in the essential fatty acid content of the lipids extracted from the dough or bread made from it.[26] There appears to be no significant difference in the vitamin B_1, riboflavin, nicotinic acid or vitamin E content of bread made from flour treated with 200 p.p.m. of ascorbic acid as compared with bread made from untreated flour. No information is available as to the effect of ascorbic acid on other flour constituents.

(*b*) **Flour for cake and biscuit manufacture**

52. **Chlorine.** This gas has both a bleaching and "improving" effect on flour. Some 25 years ago it was employed as a mixture of 99·5% chlorine and 0·5% nitrosyl chloride at levels of about 400 p.p.m. for treating bread flour, but it has been replaced by more effective agents. It is, however, used in the production of flour for the manufacture of certain types of cakes such as Angel food and layer cakes. Flour for these cakes may be treated with upwards of 4 oz. per sack of flour (900 p.p.m.). The use of chlorine in cake flour is in quite a different category from the use of commercial chlorine dioxide containing 20% chlorine for treating bread flour, which would only result in the introduction into the flour of the trivial amount of about 4 p.p.m. of chlorine.

53. Chlorine combines with the colouring matter of flour to form a colourless addition compound. Some 45% of the added chlorine combines with the flour oil, some associates itself with the starch and to a less extent with the protein. The remainder, about 50% of the whole, appears in the flour as hydrochloric acid or chlorides. Chlorine acts energetically upon gluten and enters into important parts of the gluten complex such as the tyrosine and tryptophan groupings reducing the nutritive value of the gluten.[1]

54. In a feeding trial on rats with flour treated with chlorine at the commercial levels formerly used for bread flour (200–400 p.p.m.), no significant differences were observed between the test animals and controls, but the results were regarded as inconclusive.[1] The 1927 Departmental Committee considered that the treatment of flour with chlorine was undesirable. No long-term chronic toxicity studies appear to have been carried out on flour heavily treated with chlorine. In our view the available data are inadequate to evaluate the potential health hazard of the treatment of flour with chlorine at the levels used in cake flours.

55. **Sulphur dioxide.** This gas is either used as such by the miller, or in the form of sodium bisulphite by the miller or biscuit manufacturer. It is only used for the treatment of flour used for making biscuits, the normal level of use being about 20 p.p.m. sulphur dioxide.

56. Sulphur dioxide at the levels used as a preservative (350 p.p.m.) is known to inactivate thiamine. Experiments done for us with flour containing 20 p.p.m. sulphur dioxide have shown that destruction of thiamine depends almost entirely upon the pH of the dough and not upon the presence of the sulphur dioxide. When the dough is slightly alkaline (pH greater than 7), destruction of thiamine is almost complete irrespective of whether sulphur dioxide is present or not. With doughs on the slightly acid side of neutrality (pH less than 7), destruction of thiamine is only slight and no significant contribution to the extent of destruction can be attributed to the presence of sulphur dioxide.

DISCUSSION OF THE DATA

57. In the foregoing notes on each of the chemical treatments of flour at present practised in this country we have indicated where the biological evidence is incomplete. In reviewing the evidence we have had regard to the reaction of the substance with the flour constituents which may result in loss of nutritional value, give rise to the formation of injurious substances, or lead to objectionable residual breakdown products in the treated flour. It seems to us that the combined effect of these three aspects can best be evaluated by long-term chronic toxicity studies. Such data are not available for all the substances reviewed. Furthermore, of those that have been most fully investigated, differences of opinion exist as to the significance of the adverse effects which have been recorded in some of the experiments. In no case do we regard the data as adequate for the expression of a final opinion as to the absolute safety of the treatments.

(*a*) Bread flour

58. We formed the opinion that the chemical maturing agent least open to objection was ascorbic acid. Of the other substances, the available data do not suggest that at the current commercial levels of use they give rise to substances that would render the flour injurious to health, or significantly impair its nutritional value for human beings. The adverse effects noted at higher levels of treatment cannot be entirely disregarded, even though these levels may be impractical on technological grounds. We consider that further well-designed chronic toxicity studies are desirable on the bleaching and maturing substances now in use and that they should be re-examined when the results are available. As flour is not consumed as such we think that in such studies treated flour should be fed in the form of bread and this would also take account of any changes which occur on baking. In the meantime we do not feel justified in recommending on health grounds the discontinuance of the maturing of bread flour with ascorbic acid, commercial chlorine dioxide, potassium bromate, ammonium or potassium persulphate, or of bleaching with benzoyl peroxide or nitrogen peroxide.

59. We think it desirable that the number of substances employed for the treatment of flour should be kept to a minimum consistent with technological needs and that no new chemical treatment should be permitted until it has been adequately tested and officially approved. The position should be reviewed as new evidence becomes available, and in any case in 3–5 years' time.

60. It follows from this and the considerations set out in paragraph 24, that the number of flour bleaching agents should be kept to a minimum. The bleaching agent most widely in use in the United Kingdom is benzoyl peroxide and we think that use of this substance should suffice to meet the reasonable needs of the industry. As this substance is not self-limiting in use, as are the maturing agents, we recommend that a limit of 50 p.p.m. be set. We do not anticipate any difficulty in the enforcement of this limit by analytical means. But since it would be our intention that our recommendations should also apply to imported flour it seems desirable to know if the chemical treatments permitted in exporting countries can be detected, and whether the level of treatment can be determined for all substances. We referred this problem to an analytical panel whose report is at Sub-appendix D.

(*b*) **Cake and biscuit flours**

61. We are unaware of any chronic toxicity studies on which to base an opinion on the possible health hazard of heavily chlorinated cake flour or of biscuit flour treated with sulphur dioxide. On the other hand, we know of no evidence to lead us to suppose that the treatment of biscuit flour with 20 p.p.m. sulphur dioxide would be hazardous to health. Objections were raised on nutritional grounds to the treatment of flour with chlorine by the 1927 Departmental Committee and we also would be averse to the treatment of bread flour with chlorine as formerly practised. The nutritional aspect may not, however, be of much importance when the very much smaller consumption of "high-ratio" cake flour is taken into account. Production data indicate that the amount of chlorinated flour in all cakes produced is not more than 1·5% of the total flour production. We consider that chronic toxicity studies should be done on both these flour treatments, but in the meantime we do not feel justified in recommending their discontinuance on health grounds.

RELATION TO THE REPORT ON PRESERVATIVES

62. If the recommendations of the Food Standards Committee Report on Preservatives are given statutory effect it would seem that provision will need to be made for the treatment of flour with benzoyl peroxide and possibly for some of the other agents used for treating flour. This could be done by specifically exempting "substances permitted for the bleaching and/or maturing of flour" from the definition of preservative, as is proposed for certain other classes of food additives.

THE NEED FOR MULTIPLE CHEMICAL TREATMENT

63. We are advised that of the many varieties of wheat grown, some flours respond better to treatment with one "improver" than with another. In addition, some require more bleaching than "improving" and vice versa. In the production of flour of the standard quality required by the baker the miller has regard to these factors and employs the most suitable treatment or combination of treatments to achieve this end. When a multiple chemical treatment is given we are informed that the levels of use of the individual substances are proportionately reduced, so that in practice there is little likelihood of the optimal maturing treatment being exceeded. In the case of supplies to very large bakeries, where the miller knows the precise requirements of his customer, he is able by suitable treatment to produce flour consistently of the quality and character desired. In other cases it may be necessary for some final adjustment to be made by the baker; thus, it is a common practice for bakers to add some potassium bromate.

LABELLING AND ADVERTISING OF FLOUR BLEACHING AND/OR MATURING AGENTS AND OF CHEMICALLY TREATED FLOUR

64. At the present time there are no regulations in respect of the labelling and advertising of substances sold for the bleaching and/or maturing of flour. The Labelling of Food Order, which stipulates the labelling requirements for pre-packed foods sold by retail, does not require pre-packed flour to bear a declaration of any bleaching or improving agent with which it has been treated. Some representations have been made to the Food Standards Committee that the consumer should be told in clear terms what substances have been added. We find it difficult to believe that declaration of the bleaching and/or maturing agents used in the production of the flour would serve any useful purpose to the consumer; but it would obviously present difficulties to the packer.

65. We think it should be made an offence to advertise for sale, or sell, any substance for flour bleaching and/or "improving" other than the ones which we have recommended should be used; or to recommend a proposed substance for like use contrary to our recommendations (see paragraph 66).

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

66. (i) To produce a loaf of good volume and texture, maturing of flour is necessary. This can be achieved by storage of flour in the air, aeration of the dough or treatment of the dough with small quantities of chemical substances (paragraph 23).

(ii) Although we would prefer that the maturing of flour be accomplished without chemical treatment, natural aging cannot be relied upon to give a flour of sufficiently uniform bread-making performance irrespective of the grist available (paragraph 23).

(iii) A further study of aeration techniques is desirable and of alternative physical methods of bread making (paragraph 23).

(iv) At present, the use of some form of chemical "improver" is a technological necessity (paragraph 23).

(v) There is no strong justification for the use of bleaching agents. The number permitted should be kept to the minimum, and maximum levels should be prescribed for those permitted (paragraph 24).

(vi) Only treatments which do not significantly reduce the nutritional value of the flour or do not give rise to harmful substances by reaction with the constituents of the flour should be permitted (paragraph 27).

(vii) All bleaching and improving agents in use should be subject to well-designed, long-term chronic toxicity studies (paragraph 58).

(viii) Pending such studies, only treatment with the following substances should be permitted:

Benzoyl peroxide (bleaching agent)
Ascorbic acid (maturing agent)
Potassium bromate (maturing agent)
Ammonium or potassium persulphate (maturing agent)
Commercial chlorine dioxide (maturing agent)
Chlorine (for cake flour only)
Sulphur dioxide (for biscuit flour only)

(paragraphs 58 and 61).

(ix) The amount of benzoyl peroxide allowed in flour should not exceed 50 p.p.m. No specific limits are proposed for the maturing agents (paragraph 60).

(x) No substance should be advertised for sale, or sold as a bleaching and/or maturing agent for flour other than those recommended in (viii) above (paragraph 65).

(xi) The treatment of flour with the tentatively permitted substances should be examined as further biological data become available, and in any case in 3–5 years' time (paragraph 59).

REFERENCES

1. Ministry of Health (1927): Report of the Departmental Committee on the Treatment of Flour with Chemical Substances.
2. Horder, Lord, Dodds, C. and Moran, T. (1954): *Bread*, Constable, London.
3. Mellanby, E. (1946): *Brit. Med. J.*, **2,** 885. "Diet and Canine Hysteria".
4. Mellanby, E. (1947): *Brit. Med. J.*, **2,** 288. "Further observations on the production of canine hysteria by flour treated with nitrogen trichloride".
5. Bentley, H. R., McDermott, E. E., Moran, T., Pace, J. and Whitehead, J. K. (1950): *Proc. Royal Soc.* **B.137,** 403. "Action of Nitrogen Trichloride on certain Proteins. I—Isolation and Identification of the Toxic Factor".
6. Moran, T. (1952): *Proc. Roy. Soc. Med.*, **45,** 677. "Symposium on certain agents used in milling and baking—Chemical reactions involved in flour improvement".
7. Minister of Food (1954): *Hansard*, **535,** 274.
8. Kent-Jones, D. W. and Amos, A. J. (1957): *Modern Cereal Chemistry*, 5th Ed. Northern Publ. Corp., Liverpool.
9. Bennett, Ruth and Coppock, J. B. M. (1957): *J. Sc. F. & Agric.*, **No. 5,** 261. "The Natural Aging of Flour".
10. Hamill, J. M. (1911): Local Government Board, Food Rept. No. 12. "Bleaching of flour and the addition of improvers to flour".
11. FAO/WHO (1958): Second Report of Expert Committee on Food Additives: "Procedures for the testing of intentional Food Additives to establish their safety for use". F.A.O. Nutrition Meetings Report Series No. 17.
12. Moran, T., Pace, J. and McDermott, E. E. (1953): *Nature*, **171,** 103. "Interaction of chlorine dioxide with flour; certain chemical aspects".
13. Mason, E. L. and Jones, W. L. (1958): *J. Sc. F. & Agric.*, **9,** 524. "The tocopherol content of some Australian cereals and flour milling products".
14. Newell, G. W., Gershoff, S. N., Suckle, H. M., Gilson, W. E., Erickson, T. E. and Elvehjem, C. A. (1949): *Cereal Chemistry*, **26,** 160.
15. Meredith, P., Sammons, H. G. and Frazer, A. C. (1956): *J. Sc. F. & Agric.*, **7,** 361. "Studies on the effects of treatment with chlorine dioxide on the properties of flour". I—"Chemical Composition of Protein of treated flours".
16. Frazer, A. C., Hickman, J. R., Sammons, H. G. and Sharratt, M. (1956): *Ibid.*, 371. II—"Nutritional value of Proteins of treated flours".
17. Frazer, A. C., Hickman, J. R., Sammons, H. G. and Sharratt, M. (1956): *Ibid.*, 464. IV—"Biological properties of untreated, normally treated and overtreated flours".
18. Frazer, A. C., Hickman, J. R., Sammons, H. G. and Sharratt, M. (1956): *Ibid.*, 375. III—"Lipid changes and Vitamin content of treated flours".
19. Moran, T., Pace, J. and Hutchinson, J. B. (1955): *J. Sc. F. & Agric.*, **6,** 324. "Toxicity Trials—Palatability of the diet as a factor in experiments on the rate of growth of rats".
20. Moore, T., Sharman, I. M. and Ward, R. J. (1957): *J. Sc. F. & Agric.*, **No. 2,** 97. "The Destruction of Vitamin E in flour by chlorine dioxide".
21. Moore, T., Sharman, I. M. and Ward, R. J. (1958): *Brit. J. Nutr.*, **12,** 215. "Flour and bread, prepared with or without treatment with chlorine dioxide, as long-term sources of Vitamin E for rats".
22. Menger, A. (1957): *Brot und Gebäck*, **10,** 167.
23. Moran, T., Pace, J. and McDermott, E. E. (1954): *Nature*, **174,** 449. "The Lipids in Flour. Oxidative changes induced by storage and improver treatment".
24. Monier-Williams, G. W. (1911): Local Government Board, Food Report No. 12. "Chemical changes produced in flour by bleaching".
25. Harrel, B. C. (1952): *Ind. Eng. Chem.*, **44,** 95. "Maturing and bleaching agents used in the production of flour".
26. Fisher, Mrs. N., Ritchie, M. L. and Coppock, J. B. M. (1958): *Chem. & Ind.*, p. 1361. "Essential fatty acid retention in flour bleaching and treatment".
27. Engel, C. (1942): *Z.f. Vitamin forsch.*, **12,** 20.
28. Amos, A. J. (1951): *Chem. & Ind.*, p. 946. "Flour and Bread improvers and flour bleachers".
29. Fisher, N., Ritchie, M. L. and Coppock, J. B. M. (1958): *Chem. & Ind.*, p. 720. "Essential fatty acid retention during certain oxidative flour and dough treatments and in bread making".
30. Dory, J. M. and Sherwood, R. C. (1950): *Cereal Chem.*, **27,** 409. "Ammonium persulphate as a flour improving agent".
31. Arnold, A. and Goble, F. C. (1950): *J. Nutr.*, **41,** 459. "Observations on the prolonged feeding to rats of flour matured with ammonium persulphate".
32. Moore, T. (1960): Report to the Sub-Committee.

List of organisations which gave evidence:

British Baking Industries Research Association
Cake and Biscuit Alliance Limited
Incorporated National Association of British and Irish Millers
National Association of Master Bakers, Confectioners and Caterers
Parliamentary Committee of the Co-operative Union
Scottish Association of Master Bakers

Allinson Limited
British Arkady Limited
British Soya Products Limited
Henry Simon Limited
Novadel Limited
Wallace and Tiernan Limited

Press Notice

27.1.50—No. 12

AGENE TREATMENT OF FLOUR

A Scientific Committee, under the Chairmanship of Sir Wilson Jameson, Chief Medical Officer of the Ministry of Health, and comprising representatives of the Ministries of Food and Health, the Medical Research Council, and the milling industry, has for some time been engaged on a review of the available evidence regarding any possible toxic effects of the commonly used flour improver, nitrogen trichloride, known as agene. The reason for this review was the discovery that the feeding of large quantities of flour treated with agene caused severe toxic symptoms (canine hysteria) in dogs and certain less severe symptoms in a few other animal species, e.g. rabbits.

The Committee has been unable to find any evidence that agenised flour is in any way toxic to man; experiments carried out both in this country and in the United States have failed to produce any toxic symptoms, even where heavily-treated flour has been fed at a high level. Nevertheless, in view of its deleterious effect on certain animals, the Committee has felt that the use of agene should be discontinued.

The Committee is, however, satisfied that if a loaf acceptable to the general public is to be produced in this country some form of "improver" must continue to be used to safeguard its baking qualities. There exists a suitable substitute in the form of chlorine dioxide. Extensive tests have shown that flour treated with this improver, which is used in quantities of less than 30 parts per million, causes no toxic symptoms in either animals or man. The Committee has, therefore, recommended that this improver should be adopted in the United Kingdom in place of agene. This recommendation has been accepted by the Ministries of Food and Health and by the milling industry.

It will be understood that a change in technique which affects over 90% of the flour used in this country cannot be effected overnight. The position is complicated by the fact that the necessary plant and supplies of the new improver have to be secured from the United States. Every effort is, however, being made to accelerate the change, in the execution of which the representatives of the milling industry have given an assurance of their fullest co-operation.

In the meantime, the public can be assured that the present methods of treatment of flour, which have been in operation in this country, the United States, and Canada for some 25 years, and which include agenisation, have not been proved to be injurious in any way to human health.

MINISTRY OF HEALTH AND MINISTRY OF FOOD

ANALYTICAL PANEL

Report on the Detection and Estimation of Flour Improvers or Bleaching Agents

1. We were asked to consider the present knowledge in respect of the detection and estimation by chemical means of those agents used for maturing or bleaching flour, and whether any regulations to control the usage of these agents could be enforced.

2. From a study of the literature, it was known that information on this subject was sparse, and members were asked to contribute their own experience of work in this field, thus providing the background for this Report.

3. QUALITATIVE

3.1. **Flour.** The qualitative detection in *flour* of added bleachers and improvers by chemical methods is for the most part feasible. Advantage may be taken of the fact that most of the chemicals used are oxidising agents; thus by choice of a suitable chemical reaction their presence may be demonstrated. When the chemical added is a solid, its presence in flour can usually be demonstrated directly, for example, persulphate can be recognised by its reaction with benzidine. The direct recognition of gaseous improvers on the other hand is rarely possible since unreacting gas volatilises, and demonstration of their use depends upon the recognition of some derived product, for example, the use of chlorine gives rise to chlorinated wheat fat, which may be recognised by the usual copper test for chlorinated organic compounds.

3.2. **Baked Goods.** The qualitative examination of *baked goods* for the presence of bleaching and improving agents depends solely upon this principle of the recognition of a derived product, since no improving or bleaching agent survives the baking process unchanged. Benzoyl peroxide yields an equivalent amount of benzoic acid, and any suitable qualitative test which will detect benzoic acid in small quantities can be utilised to show that the original flour had been treated with this bleacher. On the other hand, although ammonium persulphate and potassium bromate become changed during baking to ammonium sulphate and potassium bromide respectively, and the qualitative detection of the two anions is relatively simple, a positive finding does not necessarily prove the usage of either of these improvers, since both sulphate and bromide are indigenous components of the mineral matter of wheat, or may be introduced by other ingredients of the baked goods. Before the use of either improver in the original flour can be demonstrated, it must be shown that the quantity of sulphate or bromide found is greater than that normally present in flour plus the contributions made by other ingredients.

3.3. When two or more agents are present in the same sample the recognition of the individual members can be very difficult, or relatively simple, depending upon the combination present. No scheme of examination exists, but there should be no insuperable difficulty, in the case of *flour*, in recognising qualitatively each of the members of a combination in

spite of mutual interference, provided a sufficiency of appropriate tests is performed. With *baked goods*, however, the difficulties are greatly increased.

3.4. No qualitative test has been worked out for three gaseous improvers, nitrogen trichloride, nitrosyl chloride, and chlorine dioxide. The first, the "agene" process, is no longer employed, but if it were, a possible test could be framed on the detection of the resultant derivative-methionine sulphoximine. Nitrosyl chloride is rarely, if ever, used; and chlorine dioxide, when used commercially to treat flour, is never pure, but always contains some chlorine. The presence of a chlorine derived product would serve as an indirect means of recognition, but the amount so formed may frequently be smaller than the sensitivity of the copper test.

4. QUANTITATIVE

4.1. The difficulties which exist in the qualitative field are greatly increased in the respective quantitative estimations. As has been explained, if the estimation has to be based on a derived product, there must be a consequential loss of accuracy if the derived product is indigenous to wheat, e.g. sulphate, or if the derived product, e.g. chlorinated fat of wheat, does not represent the entire resultant effect of the improver. Approximations to the amount present can be obtained provided certain assumptions are made, the overall accuracy depending directly upon the validity of the assumptions made. Only when the improver or bleacher can be quantitatively isolated or directly determined can the required accuracy be assured.

4.2. The amount of the various improving or bleaching agents added to flour also has a bearing on the accuracy of the estimations—the smaller the quantity the greater the inherent error. Generally, the amounts added commercially are quite small, for example, potassium bromate 15 p.p.m., chlorine dioxide (average) 16 p.p.m., benzoyl peroxide 40 p.p.m. and ammonium persulphate 100 p.p.m. Only in the case of chlorine, and then for a specialised type of cake flour, does the amount added (1,000 p.p.m.) become appreciable.

4.3. **Flour.** In consequence the number of chemicals which can be quantitatively determined with the required degree of accuracy is small, and is limited to their occurrence in flour. Residual sulphur dioxide can be determined; potassium bromate, potassium iodate, and possibly ammonium persulphate, provided these occur singly, can be determined with fair accuracy; and benzoyl peroxide can be determined by the amount of benzoic acid formed from it.

4.4. **Flour and Bread.** For the remaining chemicals used in *flour*, and for all bleaching and improving agents in *baked goods*, the quantitative estimation is subject to a degree of inaccuracy, the magnitude of which depends upon the particular chemical in question. Benzoic acid, and hence benzoyl peroxide can be determined in baked goods, but some benzoic acid is lost in the baking process thus giving rise to a small indeterminate error. In some instances quantitative methods do not exist, chlorine dioxide, for example, which is used to treat much of the bread flour produced in this country, cannot be estimated quanti-

tatively, except perhaps by measuring the effect of the concomitant chlorine, which itself is subject to imprecision because of the variable proportions of chlorine and chlorine dioxide in the commercial gaseous improver.

5. CONCLUSIONS

5.1. The presence of improving and bleaching agents in flour can in most instances be detected qualitatively with a fair degree of certainty.

5.2. In baked goods, only benzoyl peroxide and chlorine can be detected qualitatively, in all other cases assumptions must be made and/or semi-quantitative methods employed.

5.3. The quantitative determination of the amounts of improving or bleaching agents in flour is possible in the case of residual sulphur dioxide, benzoyl peroxide, potassium bromate, potassium iodate, and possibly ammonium persulphate, provided that combinations of the last three agents are not present, and that a small error can be tolerated.

5.4. The quantitative determination or estimation of the remaining agents in flour, and all bleaching and improving agents save benzoyl peroxide in baked goods is, in the present state of knowledge, not feasible. Generally, the figure obtained by the analyst bears little relationship to the amount of bleaching or improving agent added to the flour. If various assumptions are made it is possible to obtain a roughly quantitative estimate of the level of treatment given but the accuracy is poor.

6. From the foregoing, it can be seen that the existing knowledge on the qualitative recognition of bleaching and improving agents in flour is sufficient to give reasonably good indication of their presence, but the position as regards baked goods is much less satisfactory. At the present time, the scientific foundation for the quantitative estimation of the amounts present of these agents is, with the exception of benzoyl peroxide, not sufficiently strong to permit the equitable enforcement of regulations containing limits for these chemicals in flour and baked goods.

APPENDIX VI

REPORT ON MILK BREAD

Introduction

1. Because of the uncertainty at the present time as to what descriptions are acceptable for purposes of the Food and Drugs Act for breads containing skim milk solids, the Committee decided to consider and report on this problem separately and in advance of its report on bread and flour standards generally.

2. The Committee has consulted those concerned with enforcement of food and drugs legislation and organisations representing the trade. A list of those who have given evidence is given in Sub-appendix A. In addition, the Committee has had advice from its Technical Group on Bread and Flour and from a Nutrition Panel appointed jointly with the Committee on Medical and Nutritional Aspects of Food Policy.

Historical and Technical Aspects

3. When milk bread first appeared it was made by substituting liquid milk for water as the doughing liquor. To achieve a sufficiently moist dough using milk alone requires the addition of 18–20 gallons of milk per sack of flour compared with the usual 15 gallons of water. Even then, manipulation of the dough is difficult. For this reason, and also to reduce the depressing effect which the milk solids have on the volume of the loaf, it had become common practice before 1939 to use a doughing liquor consisting of half milk and half water. Textbooks on breadmaking and other sources indicate that skim milk powder had also come into use before the war, at any rate in some areas. The extent to which skim milk powder was used, as compared with the use of milk, or milk and water, is not known. During the war the manufacture of milk bread ceased entirely, since neither liquid nor powdered milk was then available for the purpose.

4. In February, 1955, statutory provision was made for the production of "National Milk Bread", meaning national bread or national brown bread in the production of which not less than 6 parts by weight of skim milk powder had been added per 100 parts by weight of national flour or national brown flour used. Bread was decontrolled on 30th September, 1956, since when the composition and description of all breads (including milk bread) have been subject only to the general provisions of the Food and Drugs Act.

5. The provision for "National Milk Bread" was the subject of strong adverse criticism from local authorities and public analysts, who held that a "milk" bread should contain the constituents of whole milk. Since the decontrol of bread enforcing authorities have reaffirmed their view that the description "milk bread" when applied to bread made with skim milk powder is misleading, but the matter has not been tested in the Courts.

6. Doubt about the legal position is said to be hampering the sale of bread containing skim milk solids. Bread made with skim milk powder is, nevertheless, being marketed under various descriptions. Most of it contains the 6 parts of skim milk powder per 100 parts of flour which was required for "National Milk Bread", but we understand that some bakers are using approximately half this quantity in order to produce a cheaper loaf. Expressed as a percentage of the weight of the entire loaf these additions represent a skim milk solids content of approximately 4·2% and 2·1% respectively.

7. So far as we have been able to ascertain, there is now little or no commercial production of bread made with liquid milk. This is partly due to the technical problems of utilising liquid milk on any scale in the bakery and partly to its high cost compared with the use of skim milk powder. Bread of similar composition could be made with full cream milk powder or a mixture of skim milk powder and butter. Full cream milk powder is difficult to store without deterioration, and butter, besides being expensive, is claimed to be difficult to work in the dough, so that there is little commercial production of this kind. Bread made with milk as the only doughing liquor (or the equivalent in other dairy products) would contain 5·5%–6·2% total milk solids, according to the composition of the milk and the volume used, or approximately half this quantity if a mixture of equal parts of milk and water were used.

8. The use of milk in bread is said to reduce the rate of fermentation and produce a more closely textured loaf. To counteract these effects some addition of fat is considered necessary. Even with the pre-war practice of using 50% whole milk in the doughing liquor, some additional fat was used fairly extensively: this was not always butter. With the use of 6 parts of skim milk powder per 100 parts of flour, something of the order of 5–10 lb. of fat per sack may be added in order to avoid impairment of loaf quality. This can be achieved by adding butter or some other fat; lard or compound cooking fat is normally used. The addition of glyceryl monostearate and/or potassium bromate reduces the amount of additional fat needed but it is still the practice in this country to add some fat to breads containing skim milk powder.

Advice of the Nutritional Panel

9. The various additions of milk solids enumerated above have different effects on the composition of bread, the most notable effects being on the protein, calcium and riboflavin content. Detailed figures are shown in Sub-appendix B. In making these calculations no allowances were made for the effect of baking on the nutritive value of liquid milk (columns 3, 4 and 5) or skimmed dried milk (in columns 6 and 7). When milk is heat processed, losses in nutrients, particularly protein, calcium and riboflavin, are slight, and it has been assumed that losses of these nutrients during baking would also be unimportant.

10. The nutritional importance of such breads was assessed by assuming them to be eaten instead of white bread by various types of family surveyed in the National Food Survey in 1957. This calculation suggested that the consequential addition to protein content would not be quantitatively significant in the context of the present British diet. As bread and flour supply only about 2% of the total fat content of the diet, even the threefold increase in the fat content of bread containing 5½% whole milk solids (see Sub-appendix B, columns 2 and 3) could not have a significant effect on the total fat intake. On the other hand, because of the initial levels of intake of calcium and riboflavin, particularly in the larger families, the increase for these two nutrients is regarded as significant when the bread contains 4% or more of milk-solids-not-fat. Even when it contains 3%, which is the case when the whole milk solids are 4·2% (col. 4, Sub-appendix B), the increase is of some, though less, importance. Thus, there is a nutritional case for distinguishing bread containing 3% or more milk-solids-not-fat, with or without the addition of fat.

Views of Interested Parties

11. The local authority associations and the Association of Public Analysts have reiterated to us their view that the description "milk bread" unqualified

should be applied only to a product which contains the constituents of whole milk. In this they were supported by the Milk Marketing Boards. The baking industry and the milk powder manufacturers, on the other hand, consider that established trade practices, and the precedent set by the provision for "National Milk Bread" during the control period, entitle bakers to call bread made with milk solids "milk bread". They proposed that a product made with whole milk solids should be distinguished from the skim milk product either by suitable declaration of the milk product used or else by qualifying descriptions such as "dairy milk bread", "whole milk bread", "full cream bread", or "superior milk bread". The trade were strongly opposed to any requirement to describe bread made with skim milk powder as "skim milk bread": they believe this would have a detrimental effect on sales. The enforcing authorities recognised the force of this argument and were prepared to accept an alternative description like "dairy bread". The latter description for the skim product is also favoured by the Milk Marketing Boards. Alternative suggestions made for the description of the product made with skim milk were "half milk bread", "milk (skim) bread", or a coined name such as "prolac" or "lactic" bread.

12. On standards of composition there is general support for a minimum standard for the skim milk product equivalent to the use of 6 parts of skim milk powder per 100 parts of flour, except on the part of one section of the baking industry which favours a lower standard for technical and economic reasons. The enforcing authorities consider that the minimum standard for the whole milk product should be 8 parts of whole milk solids per 100 parts of flour (i.e. the equivalent of using liquid whole milk as the only doughing liquor). The trade, however, emphasised the technical difficulties of working to this standard using liquid milk.

Case for Regulations

13. Milk bread is chiefly bought because of the flavour and texture imparted by the milk solids. To some extent it competes with other fancy breads such as "malt loaf" and to some extent with ordinary white bread. The fact that the purchaser would normally pay more for a product sold as "milk bread" indicates the desirability of regulating the minimum amount of the milk solids addition.

14. Secondly, claims are likely to be made that the addition of milk solids improves the nutritional value of the loaf. Indeed, the description "milk bread" itself might well be assumed to imply some special nutritional value. It is, therefore, desirable to ensure that any addition of milk solids will contribute significantly to the nutritional value of the loaf and that any claims made are justified.

15. Thirdly, since the purchaser may be offered bread of similar appearance containing in the one case the constituents of whole milk and in the other only the solids-not-fat of milk (even if supplemented by vegetable fats), it is desirable that he should have some means of distinguishing between the two.

16. We have considered appropriate measures to control the composition, description, and the labelling and advertising of breads containing milk solids in the light of the above desiderata.

Minimum Standards

17. In our opinion, a standard is necessary to establish the minimum amount of milk-solids-not-fat in bread made with skim milk powder. We consider this

should be based on the addition of not less than 6 parts by weight of skim milk powder per 100 parts by weight of flour. This addition was prescribed in 1955 and is the amount most usually employed at present. We are satisfied that bread of high quality can be made with this amount and that it is desirable to set the minimum standard at this level in order to ensure a significant increase in the nutritional value of the loaf. If bakers wish to add smaller amounts of skim milk powder to improve the quality of their bread, they should be free to do so, but not to sell the product under a special designation.

18. To facilitate enforcement, the minimum standard of milk solids should be expressed in any regulations as a percentage of the total weight of the bread. With bread of normal moisture content (say, 40%) the use of 6 parts of skim milk powder per 100 parts of flour would give approximately 4·2% of milk-solids-not-fat in the loaf.*

19. Although the typical present-day product is made with skim milk powder, we consider that separate provision should also be made for milk bread made with liquid whole milk (or its equivalent in the form of full cream milk powder or skim milk powder and butter). We accept that a standard for a whole milk product which required the complete replacement in the doughing mixture of water by milk would make it unlikely that bread containing whole milk solids would ever be extensively made. The minimum standard should therefore allow some latitude, equivalent to the use of a mixture of milk and water. This can be done by fixing the standard at the same percentage as for the skim milk product, i.e. 4·2% of milk solids in the loaf, but relating this to whole milk solids instead of to skim milk solids. While the amounts of calcium and riboflavin added will be less than with the skim milk product, we are advised that they will still be of significance. A standard of 4·2% whole milk solids in the bread could be obtained with the use of about 14 gallons of milk per sack of flour, or by the addition of, say, 6 parts of full cream milk powder per 100 parts of flour.

Descriptions

20. We reject a solution to the problem of nomenclature which involves qualifying the term "milk bread" by the word "dairy", "whole", "superior", etc., when applied to a product containing whole milk or its equivalent. It has been argued that our proposal for "dairy ice cream"† creates a precedent for the description "dairy milk bread", but we cannot accept this view. The basis of our recommendations in the report in question was that the description "ice cream" by itself was not regarded by the consumer as implying a dairy product, and that the qualification "dairy" to denote the use of milk fat was, in the circumstances, legitimate. This argument could not be applied to the term "milk bread" which clearly connotes the use of a dairy ingredient.

21. On the other hand, we accept the view of the trade that to insist on the description "skim milk bread" for the product made with skim milk solids might have a deleterious effect on sales. While it can be argued that the description "milk bread" unqualified when applied to a product made with only part of the milk would be misleading, it is more than likely that the term "skim milk bread" would prove derogatory because of the mistaken belief that skim milk is a by-product of little value. As we have pointed out above, any nutritional advantage which can be claimed for this type of loaf is attributable

* But see paragraph 68 of the main report.
† Food Standards Committee Report on the Ice Cream Standard, H.M.S.O. 1957.

to the presence of the non-fatty solids of milk and we are unwilling to make any recommendation that might seem to carry a contrary implication. We have also considered the alternative suggestions referred to in paragraph 11 for the description of the skim milk product and have come to the conclusion that none of these is suitable.

22. These considerations appear to us to permit of only two possible solutions. The first is to call the whole milk product "milk bread" and the skim milk product "dairy bread" (with a declaration of the type of dairy product used) and the second is to call both products "milk bread", but to indicate in a declaration whether whole or skim milk solids are present.

23. The chief advantage of the first alternative is that it confines the term "milk bread", as ideally it should be confined, to the product made with whole milk. The term "dairy" is a generic one which could be held to cover the use of skim milk, a dairy product. Thus the two products would be clearly distinguished, even without an accompanying declaration, and a declaration in the case of "dairy bread" would help to make it clear that the product contained skim milk solids. On the other hand, the term "dairy bread" is ambiguous, and might lend itself to the misconception that "dairy bread" was superior to "milk bread". To the more knowledgeable purchaser this misconception would be the more likely to arise because in the case of ice cream the term "dairy" is used in the opposite sense, to define a product containing whole milk.

24. The Committee is fairly evenly divided between these alternatives. The *minority* hold the view that the first of the alternatives put forward in paragraph 22 above is to be preferred on the grounds that:

(i) the principle of exact description of foods is most important in itself and particularly so where milk is concerned. To approve the use of the word "milk" to describe any substance other than whole milk would almost certainly increase the difficulties experienced by food and drugs authorities in enforcing the general provisions of the Food and Drugs Act when dealing with other foods with names including the word "milk";

(ii) the housewife is likely to be misled by the use of the description "milk bread" for the skim milk product; when buying "milk bread" she probably assumes that she is obtaining bread made with whole milk;

(iii) strong representations were made by food and drugs authorities to the Ministry of Food in 1955 against the description "National Milk Bread" when the amendment to the Bread Order permitted the sale of bread containing skim milk solids under this description;

(iv) the Food and Drugs Act itself, when dealing with cream, distinguishes between that made from the cream of milk and imitation cream made from other substances; buns filled with imitation cream may not be sold as "cream buns". The minority consider that this statutory precedent should be followed.

25. On the other hand, the *majority* would allow the term "milk bread" to be applied to the skim milk product as well as to the whole milk product, subject to a declaration of content, on the following grounds:

(i) since the additional fat which would be contributed by the use of whole milk is not significant nutritionally the consumer is not prejudiced from the nutritional standpoint by the use in this particular product of skim milk solids in place of whole milk solids;

(ii) by far the greater part of the "milk bread" now manufactured is in fact made with skim milk solids;
(iii) the description "National Milk Bread" was applied to the skim milk product for which statutory provision was made in 1955 and, in view of this, the consumer might well find it difficult to understand why the term "milk bread" is no longer considered an appropriate description for bread made with the same amount of skim milk;
(iv) the term "dairy bread" is ambiguous and open to misconception, and no more satisfactory alternative to the term "milk bread" has been found.

Members subscribing to this view would regret this breach with the general proposition that the term "milk" unqualified should be applied only where whole milk is used, but they feel that the exceptional considerations set out above justify exceptional treatment.

Labelling and Advertising

26. Claims relating to the improved nutritional value of bread containing milk solids are not justified unless the bread contains at least the amount of milk solids suggested as the minimum standard for "milk bread". Even with milk bread conforming to the recommended minimum standard, the amount of milk solids added does not appear to justify claims that the bread is "rich in" milk protein or milk nutrients. No objection need be taken to a statement in any label or advertisement (in addition to the declaration proposed in paragraph 22 above) that the bread "contains added milk nutrients", or a statement of the amount of milk solids or milk protein present, provided the amount is expressed as a percentage of the whole weight of the loaf.

27. Apart from the description "milk bread", labels and advertisements relating to bread made with skim milk only should not bear any words or pictorial devices suggesting that the bread contains whole milk.

Recommendations

28. "Milk bread" should be required to contain not less than 4·2%* by weight of whole milk solids or skim milk solids, calculated on the weight of the loaf.

29. Labels and advertisements for milk bread should be required to bear a declaration in prescribed form "contains whole milk solids" or "contains milk solids not fat", as the case may be, and where milk bread is sold unwrapped a notice should be conspicuously displayed in the shop to the same effect.

30. Statements in labels or advertisements that milk bread is rich in any of the nutrients contained in milk, and words or pictorial devices suggesting that milk bread containing skim milk solids has been made with or contains the constituents of whole milk should be prohibited.

Enforcement

31. We are satisfied that the above recommendations can be satisfactorily enforced. The amount of milk-solids-not-fat in bread can be determined with a reasonable degree of accuracy. In the case of bread containing whole milk solids it will also be necessary to determine the amount of butterfat present. No difficulty is envisaged by the Association of Public Analysts in determining with reasonable accuracy the amount of butterfat in the bread.

32. For the purpose of formal samples it may be necessary to take three loaves in order to obtain a representative part in each of the three parts of the sample.

* But see paragraph 68 of the main report.

List of organisations which gave evidence:—

Association of County Councils in Scotland
Association of Municipal Corporations
Association of Public Analysts
Counties of Cities Association
County Councils' Association
Institute of Weights and Measures Administration
Metropolitan Boroughs' Standing Joint Committee

Aberdeen and District Milk Marketing Board
British Baking Industries Research Association
Federation of Wholesale and Multiple Bakers
Milk Marketing Board of England and Wales
Milk Marketing Board for Northern Ireland
Milk Powder Council
National Association of Master Bakers, Confectioners and Caterers
North of Scotland Milk Marketing Board
Parliamentary Committee of the Co-operative Union
Scottish Association of Master Bakers
Scottish Milk Marketing Board

Dr. D. W. Kent-Jones

Composition of White Bread with and without the Addition of Whole Milk or Skim Milk Powder at Different Levels

per 100 *g.*

Nutrient (1)		No Addition of milk (2)	Bread containing:				
			Whole Milk Solids			Skim Milk Solids	
			(3) 5·5%	(4) 4·2%	(5) 3·0%	(6) 4·2%	(7) 2·1%
Energy value	Cal.	257·0	268·0	264·0	264·0	261·0	257·0
Protein	g.	7·8	8·8	8·5	8·5	9·2	8·5
Fat*	g.	0·7	2·1	1·8	1·4	0·7	0·7
Carbohydrate	g.	54·7	53·6	54·0	54·0	54·3	54·3
Calcium	mg.	102·0	145·0	134·0	127·0	148·0	127·0
Iron	mg.	1·45	1·42	1·43	1·44	1·44	1·45
Thiamine	mg.	0·162	0·169	0·166	0·162	0·173	0·166
Riboflavin	mg.	0·025	0·085	0·071	0·056	0·088	0·056
Nicotinic Acid	mg.	1·49	1·45	1·46	1·47	1·47	1·48

* No allowance is made in these calculations for the contribution of any other fats that might be added to the bread (see paragraph 8 of report).

COMPARATIVE TABLE

Form of milk addition	Expressed as parts per 100 parts of flour			Expressed as % of bread weight		
	Milk fat	M.S.N.F.	Total	Milk fat	M.S.N.F.	Total
1. Liquid milk as only doughing liquor (say 18–20 gals. per sack of flour)	2	6	8	1·4–1·7	4·1–4·5	5·5–6·2
2. Liquid milk as half the doughing liquor (say 9–10 gals. per sack of flour)	1	3	4	0·7–0·85	2·05–2·25	2·25–3·1
3. 14 gals. of milk per sack of flour (recommended minimum standard)	1·6	4·4	6	1·1	3·1	4·2
4. Skim milk solids at rate of 6 parts per 100 parts of flour (recommended minimum standard)	0	6	6	0	4·2	4·2
5. Skim milk solids at rate of 3 parts per 100 parts of flour	0	3	3	0	2·1	2·1

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